CHEMWATCH

Bulletin Board

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ASIA PACIFIC

Web-based intervention reduces EDC exposure levels

2021-07-08

In an article published on June 23, 2021, in the *International Journal of Hygiene and Environmental Health,* Ju Hee Kim and colleagues from *Kyung Hee University*, Seoul, South Korea developed a web-based behavioral intervention program intended to "reduce exposure to phthalate metabolites, bisphenol A, triclosan, and parabens in mothers with young children." The program focused on human behavior regarding food intake (e.g., more organic foods, less fish, animal fat, and dairy products), use of personal care products (e.g., no cosmetics, less color makeup), and other health-related habits such as frequent hand washing, sweating, and use of glass and stainless steel for cooking. The implementation of the web-based intervention program was based on five pillars: "an educational video explaining the health effects of endocrine disruptors as well as steps to reduce exposure to them; a game to find items containing endocrine disruptors at home; a search for facilities that release endocrine disruptors; resources; and a questions and answers mode."

Kim et al. compared 26 participating mothers with access to the intervention website to a control group of 25 mothers supplied with written information on endocrine disrupters. The authors analyzed a questionnaire the participants completed and sampled the urine of the participants before, after the first week, and at the end of the intervention. They measured changes in the concentration of six endocrine disrupting chemicals (EDCs): mono (2-ethylhexyl) phthalate (MEHP, CAS 4376-20-9), mono (2-ethyl-5-oxohexyl) phthalate (MEOHP, CAS 40321-98-0), bisphenol A (BPA, CAS 80-05-7), methylparaben (MP, CAS 99-76-3.), ethylparaben (EP, CAS 120-47-8), and propylparaben (PP, CAS 94-13-3). After the one-month intervention, the urinary concentrations of all six analyzed EDCs had significantly decreased in the web-based intervention group compared to the control group. Based on their findings, the scientists consider web-based behavioral interventions as an effective tool to reduce EDC exposure in mothers with young children. While they analyzed urine samples taken in the morning, they propose that future studies should take several samples a day to consider intra-day variations, and to also analyze changes in health behavior.

The authors analyzed a questionnaire the participants completed and sampled the urine of the participants before, after the first week, and at the end of the intervention.

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Food Packaging Forum, 8 July 2021

https://www.foodpackagingforum.org/news/web-based-intervention-reduces-edc-exposure-levels

New Zealand and two Australian states phase our single-use plastics

2021-07-01

On June 27, 2021, New Zealand's *Ministry for the Environment* announced a plan to "phase out" many hard-to-recycle plastics and single-use items, mostly related to food packaging, by mid-2025. By the end of 2022, New Zealand will no longer allow polyvinyl chloride meat trays, polystyrene and expanded polystyrene food and beverage packaging, and plastic drink stirrers. The nation is also banning degradable plastic products, such as those designed to break down through oxo- or photodegradation, because "the plastic still degrades into smaller pieces (microplastics) though at a faster rate than conventional types of plastic. These plastics are also another source of contamination for our recycling system as they cannot be composted or recycled" (FPF reported here and here). Plastic tableware, produce bags, and produce labels will be banned by mid-2023, and any remaining PVC or polystyrene food and beverage packaging by mid-2025.

According to Environment Minister, David Parker, beginning in November 2021 a new $50 million Plastics Innovation Fund "will be available for innovative projects from designing out waste in products and packaging, or adopting and scaling up existing technologies, through to switching materials and developing recycling solutions not currently available." The plastics bans and innovation fund are a follow-up to the 2019 Rethinking Plastics in Aotearoa New Zealand report and to the nearly 8000 responses the government received during the 2020 public consultation period.

Read More

Food Packaging Forum, 1 July 2021

https://www.foodpackagingforum.org/news/new-zealand-and-two-australian-states-phase-out-single-use-plastics

By the end of 2022, New Zealand will no longer allow polyvinyl chloride meat trays, polystyrene and expanded polystyrene food and beverage packaging, and plastic drink stirrers.

Reminder—Workplace Exposure Standards closes for public feedback in 3 weeks

2021-07-09

Only 3 weeks left to comment on the workplace exposure standards for airborne contaminants.

Safe Work Australia is reviewing the Workplace exposure standards for airborne contaminants (WES) to ensure they are based on high quality evidence and supported by a rigorous scientific approach.

Consultation for the final release of the draft evaluation reports closes 30 July 2021. No extensions or late submissions will be accepted.

Reports are now available for public comment. Each draft report includes:

- a recommended WES value
- information about the basis of the recommendation, and
- a summary of the data relied upon to make the recommendation.

Feedback is sought on the WES values and technical comments regarding:

- the toxicological information and data that the value is based on, and
- the measurement and analysis information provided.

The review will result in the development of a list of health-based recommendations for the workplace exposure standards in Australia. This includes recommendation on the workplace exposure standards values, notations, and the list of chemicals.

Read more information on the review or submit your comments on the last release here.

Read More

Safe Work Australia, 9 July 2021

https://www.safeworkaustralia.gov.au/media-centre/news/reminder-workplace-exposure-standards-closes-public-feedback-3-weeks

Consultation for the final release of the draft evaluation reports closes 30 July 2021.

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AMERICA

Federal legislation to regulate PFAS could get House vote this month

2021-07-08

A sweeping bill that would regulate PFAS chemicals at the federal level recently cleared a key committee in the U.S. House of Representatives.

The PFAS Action Act of 2021 passed the House Energy and Commerce Committee on June 23 with a 33-20 vote. The bill is now likely headed to the House floor, possibly within a few weeks.

If signed into law, the legislation could have significant implications for Cape Cod, where tests have shown detectable levels of PFAS in private drinking water wells and municipal water supplies.

Just this spring, testing found detectable levels of PFAS in three of Chatham's nine public drinking water wells. In one well, levels were more than twice the level allowed by the state, causing the town to immediately shut the well down.

Background:'Forever chemicals' detected in Chatham drinking water wells

While other sources are being investigated, Joint Base Cape Cod, the Barnstable Municipal Airport and the Barnstable County Fire and Rescue Training Academy have all been identified as known sources of the migrating man-made chemicals, which were present in firefighting foam used at the sites.

Read More

Cape Cod Times, 8 July 2021

https://www.capecodtimes.com/story/news/2021/07/08/bill-would-regulate-pfas-action-act-could-hit-house-floor-late-month-cape-cod-keating-dingell-upton/5370716001/

The changes include assessing exposure to chemicals from air and water, as well as from land disposal.

Big changes afoot for US chemical risk evaluations

2021-07-08

EPA seeks to restore trust and protect vulnerable populations from chemical exposures

Facing lawsuits and criticism from scientists, environmental groups, and the chemical industry, the US Environmental Protection Agency is

overhauling its approach for evaluating risks associated with high-priority chemicals that are already on the market. According to Michal Freedhoff, head of the EPA's chemicals office, the changes will impact the first 10 assessments completed by the Trump administration under the amended Toxic Substances Control Act (TSCA). They will also affect the next 24 assessments, which the EPA has already begun, and those that the agency conducts in the future.

The changes include assessing exposure to chemicals from air and water, as well as from land disposal. During the Trump administration, the EPA disregarded such pathways, claiming that they were already regulated by other statutes, such as the Clean Air Act and Clean Water Act. For 6 of the first 10 chemicals, the EPA will develop a screening approach that uses existing ambient air and surface-water data to evaluate risks to fenceline communities that border industrial facilities.

The EPA also plans to reopen its assessment of the solvent 1,4-dioxane, a widespread drinking-water contaminant, to determine whether drinking water and air exposure pose unreasonable risks to the general population. The agency will also evaluate occupational exposures to 1,4-dioxane generated as a manufacturing by-product that were not considered in its previous assessments.

One change that will affect all the first 10 chemical evaluations is a plan to abandon a use-by-use approach for determining risks. The EPA will continue analyzing risks for each specific use but will make only one unreasonable risk determination for chemicals that have significant risks across multiple uses.

Read More

Chemical & Engineering News, 8 July 2021

https://cen.acs.org/policy/chemical-regulation/Big-changes-afoot-US-chemical/99/i25

The smoke comes every year. Sugar companies say the air is safe.

2021-07-08

To harvest more than half of America's cane sugar, billion-dollar companies set fire to fields, a money-saving practice that's being banned by other countries. Some residents say they struggle to breathe, so we started tracking air quality.

Some residents say they struggle to breathe, so we started tracking air quality.

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In the fall of 2019, brothers Donovan and Jayceon Sonson spent eight weeks lying in hospital beds, struggling to breathe.

The young boys, then 5 and 6 years old, had developed upper respiratory infections on top of the severe asthma they'd had since they were toddlers.

Anytime they left their apartment, they took their "medicine box," a plastic bin filled with red inhalers, prescribed steroids and a pink nebulizer shaped like a kitten. When the hospital released the boys just before Thanksgiving, doctors sent the family home with guidance on how to protect the boys from future episodes.

Among the instructions: "Keep your child away from secondhand smoke."

Thelma Freeman, the boys' grandmother, stared at the note. She didn't smoke. Neither did anyone in her home. The problem was all around her, she thought, coming not from smokers but from an industry that provides thousands of jobs in her town: sugar.

Read More

ProPublica.org, 8 July 2021

https://projects.propublica.org/black-snow/

Coalition of chemical manufacturers, brand owners, NGOs, state, and municipalities calls on congress to restore funding for EPA's Safer Choice program

2021-07-07

On June 24, 2021, a "unique and broad group" of chemical manufacturers, brand owners, environmental non-governmental organizations (NGO), states, and municipalities sent a letter to the leaders of the House and Senate Appropriations Subcommittees on Interior, Environment, and Related Agencies to express their "strong support" for the U.S. Environmental Protection Agency's (EPA) Safer Choice Program and to encourage that the program be funded fully. The letter asks that the following language be included in the report:

The Committee supports the Safer Choice program and directs that the program be funded and operated at least at levels consistent with Fiscal Year 2014, adjusted for inflation.

According to the letter, in the last quarter of 2020, EPA reorganized the Office of Chemical Safety and Pollution Prevention (OCSPP), dissolving the Safer Choice branch and reassigning most staff to the areas of OCSPP.

According to the letter, in the last quarter of 2020, EPA reorganized the Office of Chemical Safety and Pollution Prevention (OCSPP), dissolving the Safer Choice branch and reassigning most staff to the areas of OCSPP. The letter states that "[a]s a result, the program is now severely under-resourced with approximately four full-time staff." The Biden-Harris EPA has taken steps to restore the program, but EPA still faces resource constraints.

Read More

TSCAblog, 7 July 2021

http://www.tscablog.com/entry/coalition-of-chemical-manufacturers-brand-owners-ngos-states-and-municipali

EUROPE

Amendments to the GB mandatory classification and labelling list (GB MCL list)

2021-07-08

The GB MCL list contains the legally binding mandatory classification and labelling of substances that must be used in the classification and labelling of substances and mixtures placed on the market in Great Britain.

The GB MCL list (version 1.1) has been corrected for several transcription errors and a note added clarifying the application dates for substances listed in the 14th and 15th Adaptations to Technical Progress (ATP) to the EU CLP Regulation that were published in the Official Journal and entered into force before the end of the transition period (31 December 2020).

Potential errors in the GB MCL list can be reported to GBCLP.GBMCL@hse.gov.uk

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HSE Classification Labelling and Packaging (CLP) e-bulletin, 8 July 2021

https://content.govdelivery.com/accounts/UKHSE/bulletins/2e5f709

Potential errors in the GB MCL list can be reported to GBCLP.GBMCL@hse.gov.uk

Fish are becoming addicted to methamphetamines seeping into rivers

2021-07-06

Illicit drug use is a growing global health concern that causes a financial burden of hundreds of billions of dollars in the US alone. But hidden

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beneath the societal costs of this human epidemic is a potential ecological crisis. As methamphetamine levels rise in freshwater streams, fish are increasingly becoming addicted.

"Where methamphetamine users are, there is also methamphetamine pollution," says Pavel Horký at the Czech University of Life Sciences.

Humans excrete methamphetamines into wastewater, but treatment plants aren't designed to deal with such substances. Because of this, as treated wastewater flows into streams, so do methamphetamines and other drugs.

In some streams in the Czech Republic, methamphetamine concentrations have been measured at hundreds of nanograms per litre, according to Horký and his colleagues, but the effect of these levels on aquatic animals has been unclear.

Read More

NewScientist, 6 July 2021

https://www.newscientist.com/article/2283296-fish-are-becoming-addicted-to-methamphetamines-seeping-into-rivers

EU enforcement action plan on bamboo additives in plastic FCMs

2021-07-07

On May 6, 2021, the *European Commission* (*EC),* the EU Member States, and Members of the EU Food Fraud Network have agreed to launch an EU Enforcement Action Plan on plastic food contact materials (FCMs) made with bamboo powder as an additive. This new EU enforcement aims to ensure that plastic products which contain plant-based additives not complying with EU rules do not enter the EU market and that taxes for wrongly declared plastic products are recovered. It further includes awareness-raising of consumers on the issue and that Member States' enforcement and competent authorities remind business operators of the products' illegality.

The plan was developed as a result of several dozen notifications in the Rapid Alert System for Food and Feed (RASFF) and the Administrative Assistance and Cooperation System (AAC) related to FCMs made of ground bamboo between 2019 and 2021. Most non-compliances "related to the unauthorised use of bamboo additive as a filler and/or the mislabeling of products falsely declared as made of 100% bamboo." The use of bamboo

This new EU enforcement aims to ensure that plastic products which contain plant-based additives not complying with EU rules do not enter the EU market and that taxes for wrongly declared plastic products are recovered.

and other plant-based additives in plastic FCMs is illegal in the EU since they are not authorized by the EU regulation on plastic FCMs (FPF reported). Migration studies have demonstrated that bamboo-containing plastics leach melamine (FPF reported and here), a compound that has been associated with impacts on neurological functions, behavior, reproduction, and growth (FPF reported) and that was also classified as "possibly carcinogenic to humans" (FPF reported).

Read More

Food Packaging Forum, 7 July 2021

https://www.foodpackagingforum.org/news/eu-enforcement-action-plan-on-bamboo-additives-in-plastic-fcms

INTERNATIONAL

Deaths by exposure to hazardous chemicals increased 29% between 2016 and 2019: WHO

2021-07-08

While most of these deaths are preventable, countries still don't have enough legal control on the use of hazardous compounds such as lead

Deaths due to exposure to hazardous chemicals worldwide rose 29 per cent in 2019 from what they were in 2016, according to latest estimates by the World Health Organization (WHO).

Two million people died due to exposure to hazardous chemicals in 2019, compared to 1.56 million in 2016, according to the global health body.

Hazardous chemicals are present in the air, in consumer products, at the workplace, in water, or in the soil. They can cause several diseases including mental, behavioural and neurological disorders, cataracts, or asthma.

The worrying estimates were released by Tedros Adhanom Ghebreyesus, WHO Director-General, during the Ministerial Dialogue held July 7, 2021 at the Berlin Forum on Chemicals and Sustainability: Ambition and Action towards 2030.

Between 4,270 and 5,400 people died every day due to unintentional exposure to chemicals, according to the figures. Children and young adults

Two million people died due to exposure to hazardous chemicals in 2019, compared to 1.56 million in 2016, according to the global health body.

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were particularly affected by unintentional poisoning from hazardous chemicals, WHO data showed.

The data reiterate the need for regulation and effective governance of chemicals. India too must take a note of this as the country's national chemical policy has been pending since 2012. There is a need for a comprehensive law in the country to regulate chemical use, production and safety, DD Basu, former scientist, Central Pollution Control Board, told *Down To Earth*.

In 2020, Unicef too had raised concerns on the impact of lead pollution on the health of children in its report The Toxic Truth. At least 1 in 3 children — up to approximately 800 million globally — have blood lead levels at or above 5 micrograms per decilitre (µg/dL), Unicef had said in the report.

Read More

Down to Earth, 8 July 2021

https://www.downtoearth.org.in/news/pollution/deaths-by-exposure-to-hazardous-chemicals-increased-29-between-2016-and-2019-who-77854

UV-328 elimination proposal gaining global attention

2021-07-01

In an article published on June 28, 2021, the online magazine *Unearthed* reports on recent pushback from the world's largest oil and chemical companies against a proposed listing of the plastic additive known as UV-328 (CAS 25973-55-1) into the *United Nation's* Stockholm Convention on Persistent Organic Pollutants (POPs). In January 2021, the Persistent Organic Pollutants Review Committee (POPRC) within the Convention officially reviewed and recognized that the substance fulfills the set screening criteria of: (1) persistence, (2) bioaccumulation, (3) adverse effects, and (4) potential for long-range environmental transport (FPF reported). The nomination for the listing under the Convention for global elimination was submitted by the government of Switzerland. The proposal has received wide-ranging support from members of the Convention's review committee.

However, statements from chemical industry associations and interviews with various stakeholders as reported by *Unearthed* and in a recent article in the *Daily Mail* have suggested that a restriction on UV-328 due to its identified hazardous properties would lead to "the end of plastic." This statement, however, is being seen by many stakeholders as a strongly

The proposal has received wide-ranging support from members of the Convention's review committee.

exaggerated and simply illogical prediction due to the availability of chemical alternatives on the market that could be used to replace UV-328 in global plastics manufacturing. Furthermore, UV-328 is just one of over 10'000 chemicals recently found to be intentionally added into plastics during manufacturing (FPF reported). The Stockholm Convention assesses chemicals individually against each of the four set criteria, and the recognition of UV-328's hazard properties cannot result in the automatic restriction of other plastics additives. Other chemicals would need to be screened separately within the Convention against these criteria. National governments, however, can always voluntarily decide to use their own policy mechanisms that go beyond requirements internationally agreed within the Stockholm Convention.

Read More

Food Packaging Forum, 1 July 2021

https://www.foodpackagingforum.org/news/uv-328-elimination-proposal-gaining-global-attention

ECHA ad hoc targeted public consultation: call for comments (deadline 22 July 2021)

YYYY-MM-DD

The Great Britain Mandatory Classification and Labelling (GB MCL) process includes the consideration of information gathered from public consultations, conducted by HSE or international bodies such as the European Chemicals Agency (ECHA).

ECHA has announced a targeted consultation on the harmonised classification and labelling (CLH) of lithium carbonate (EC 209-062-5; CAS 554-13-2) lithium chloride (EC 231-212-3; CAS 7447-41-8) lithium hydroxide (EC 215-183-4; CAS 1310-65-2). All three lithium compounds are chemicals registered under REACH.

The present consultation seeks comments on reproductive toxicity. The previous ECHA public consultation ended on 2 October 2020.

The detailed consultation is available on the ECHA website.

UK-based businesses with an interest in the proposal are strongly encouraged to share any relevant information.

Scientific and technical information should be submitted directly to ECHA using their commenting webform by 22 July 2021. Comments will be published on ECHA's website.

If your business is affected by the GB CLP Regulation, please also consider if you are likely to be affected by the proposal and let us know at an early stage if you anticipate any significant impacts or benefits.

Information on wider policy and impact considerations can be submitted to HSE at GBCLP.GBMCL@hse.gov.uk.

Under the GB CLP Regulation, HSE will consider all published opinions of the Committee of Risk Assessment of ECHA (RAC) before publishing its own Agency Technical Reports and Agency Opinions, so any information you provide will be important in any final GB MCL decision.

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HSE Classification Labelling and Packaging (CLP) e-bulletin, 8 July 2021

https://content.govdelivery.com/accounts/UKHSE/bulletins/2e5f709

The present consultation seeks comments on reproductive toxicity.

ECHA public consultation: call for comments (deadline 3 September 2021)

2021-07-08

The Great Britain Mandatory Classification and Labelling (GB MCL) process includes the consideration of information gathered from public consultations, conducted by HSE or international bodies such as the European Chemicals Agency (ECHA).

ECHA has announced a public consultation on the following proposals for harmonised classification and labelling (CLH):

- Acetone oxime (EC: 204-820-1; CAS: 127-06-0). Chemical registered under REACH.
- Multi-Walled Carbon Tubes (synthetic graphite in tubular shape) with a geometric tube diameter range ≥ 30 nm to < 3 µm and a length ≥ 5 µm and aspect ratio > 3:1, including Multi-Walled Carbon Nanotubes, MWC(N)T (EC: -; CAS: -).
- Propyl 3,4,5-trihydroxybenzoate (EC: 204-498-2; CAS: 121-79-9). Chemical registered under REACH.
- S-metolachlor (ISO) (EC: -; CAS: 87392-12-9). Pesticide active substance.
- Sulfur (EC: 231-722-6; CAS: 7704-34-9). Pesticide active substance.

The details can be viewed here.

UK-based businesses with an interest in the proposals are strongly encouraged to share any relevant information.

Scientific and technical information should be submitted directly to ECHA using their commenting webform by 3 September 2021. Comments will be published on ECHA's website.

If your business is affected by the GB CLP Regulation, please also consider if you are likely to be affected by any of the classification and labelling proposals and let us know at an early stage if you anticipate any significant impacts or benefits. Information on wider policy and impact considerations can be submitted to HSE at GBCLP.GBMCL@hse.gov.uk.

Under the GB CLP Regulation, HSE will consider all published opinions of the Committee of Risk Assessment of ECHA (RAC) before publishing its

UK-based businesses with an interest in the proposals are strongly encouraged to share any relevant information.

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own Agency Technical Reports and Agency Opinions, so any information you provide will be important in any final GB MCL decision.

More information on the new GB MCL system is available on the HSE website.

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HSE Classification Labelling and Packaging (CLP) e-bulletin, 8 July 2021

https://content.govdelivery.com/accounts/UKHSE/bulletins/2e5f709

Candidate list updated with eight hazardous chemicals

2021-07-08

ECHA/NR/21/20

The Candidate List of substances of very high concern now contains 219 chemicals that may harm people or the environment.

Helsinki, 8 July 2021 – Some of the newly added substances are used in consumer products such as cosmetics, scented articles, rubber and textiles. Others are used as solvents, flame retardants or to manufacture plastics products. Most have been added to the Candidate List because they are hazardous to human health as they are toxic for reproduction, carcinogenic, respiratory sensitisers or endocrine disruptors.

Companies must follow their legal obligations and ensure the safe use of these chemicals. They also have to notify ECHA under the Waste Framework Directive if their products contain substances of very high concern. This notification is submitted to ECHA's SCIP database and the information will later be published on the Agency's website.

Entries added to the Candidate List on 8 July 2021:

#	Substance name	EC number	CAS number	Reason for inclusion	Examples of use(s)
1	2-(4-tert-butylbenzyl)propionaldehyde and its individual stereoisomers	-	-	Toxic for reproduction (Article 57 c)	Cleaning agents, cosmetics, in scented articles, polishes and wax blends.

Most have been added to the Candidate List because they are hazardous to human health as they are toxic for reproduction, carcinogenic, respiratory sensitisers or endocrine disruptors.

2 Orthoboric acid, sodium salt 237-560-2 13840-56-7 Toxic for reproduction

(Article 57 c) Not registered under REACH.

May be used as solvent and corrosion inhibitor.

3 2,2-bis(bromomethyl)propane1,3-diol (BMP);

2,2-dimethylpropan-1-ol, tribromo derivative/3-bromo-2,2-bis(bromomethyl)-1-propanol (TBNPA);

2,3-dibromo-1-propanol (2,3-DBPA) 221-967-7,

253-057-0,

202-480-9 3296-90-0,

36483-57-5,

1522-92-5,

96-13-9 Carcinogenic

(Article 57 a) BMP: manufacture of polymer resins and in one component foam (OCPF) application.

TBNPA: polymer production manufacture of plastics products, including

compounding and conversion and as an intermediate.

DBPA: registered as an intermediate.

4 Glutaral 203-856-5 111-30-8 Respiratory sensitising properties (Article 57f - human health) Biocides, leather tanning, x-ray film processing, cosmetics.

5 Medium-chain chlorinated paraffins (MCCP)

(UVCB substances consisting of more than or equal to 80% linear chloroalkanes with carbon chain lengths within the range from C14 to C17) - - PBT (Article 57d)

vPvB (Article 57e) Flame retardants, plasticising additives in plastics, sealants, rubber and textiles.

6 Phenol, alkylation products (mainly in para position) with C12-rich branched alkyl chains from oligomerisation, covering any individual

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isomers and/ or combinations thereof (PDDP) - - Toxic for reproduction (Article 57c)

Endocrine disrupting properties (Article 57f - human health and environment) Preparation of lubricant additive materials and of fuel system cleaners.

7 1,4-dioxane 204-661-8 123-91-1 Carcinogenic

(Article 57a)

Equivalent level of concern having probable serious effects to the environment (Article 57f -environment)

Equivalent level of concern having probable serious effects to human health (Article 57f –human health) Solvent

8 4,4'-(1-methylpropylidene)bisphenol 201-025-1 77-40-7 Endocrine disrupting properties (Article 57f - human health and environment) Not registered under REACH.

May be used in manufacture of phenolic and polycarbonate resin.

Note: due to a technical error, the EC entry 251-823-9, EC name: tetrahydro-4-methylphthalic anhydride was mistakenly associated to an earlier Candidate List entry Hexahydromethylphthalic anhydride [including cis- and trans- stereo isomeric forms and all possible combinations of the isomers]. The associated substance tetrahydro-4-methylphthalic anhydride has now been removed from the Candidate List. The substance infocard and brief profile are being updated accordingly. We apologise for any inconvenience this may have caused.

Background

The Candidate List includes substances of very high concern that may have serious effects on our health or the environment. These substances may be placed on the Authorisation List in the future, which means that companies would need to apply for permission to continue using them. The Candidate List has now 219 entries – some of these cover groups of chemicals so the overall number of impacted chemicals is higher.

Under the REACH Regulation, companies may have legal obligations when their substance is included – either on its own, in mixtures or in articles – in the Candidate List. Any supplier of articles containing a Candidate List

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substance above a concentration of 0.1 % weight by weight has to give sufficient information to their customers and consumers to allow safe use.

Importers and producers of articles containing a Candidate List substance have six months from the date of its inclusion in the list (8 July 2021) to notify ECHA. Suppliers of substances on the Candidate List (supplied either on their own or in mixtures) have to provide their customers with a safety data sheet.

As of 5 January 2021, suppliers of articles on the EU market containing Candidate List substances in a concentration above 0.1% weight by weight must notify these articles to ECHA's SCIP database. This duty comes from the Waste Framework Directive.

More information on these obligations and related tools are available on ECHA's website.

Read More

ECHA, 89 July 2021

https://echa.europa.eu/-/candidate-list-updated-with-eight-hazardous-chemicals

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Janet's Corner

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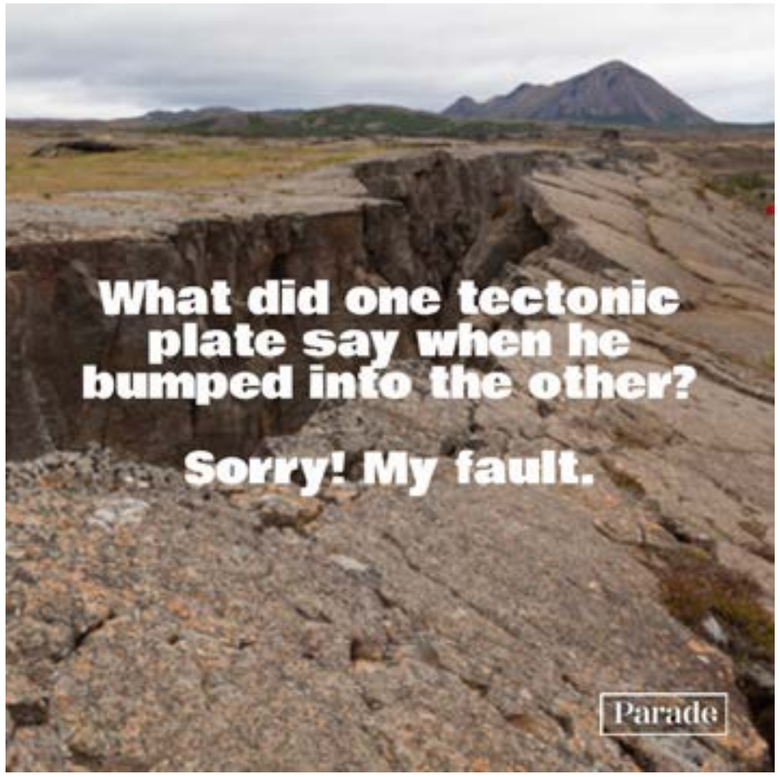
Tectonic Plate

2021-07-16



https://parade.com/1193513/marynliles/science-jokes/

White Phosphorus

2021-07-16

Phosphorus is a non-metallic chemical element with symbol P and atomic number 15. As a mineral, it is almost always present in its maximally oxidised state, as inorganic phosphate rocks. Elemental phosphorus exists in two major forms—white phosphorus and red phosphorus—but due to its high reactivity, phosphorus is never found as a free element on Earth. [1]

Pure white phosphorus is a colourless-to-white waxy solid, but commercial white phosphorus is usually yellow. Therefore, it is also known as yellow phosphorus. White phosphorus is also called phosphorus tetramer and has a garlic-like smell. In air, it catches fire at temperatures l0-15 degrees above room temperature. Because of its high reactivity with oxygen in air, white phosphorus is generally stored under water. White phosphorus does not occur naturally. Industries produce it from naturally occurring phosphate rocks. [2]

White phosphorus glows in the dark (when exposed to oxygen) with a very faint tinge of green and blue. [1]

USES [2]

White phosphorus is used mainly for producing phosphoric acid and other chemicals. These chemicals are used to make fertilisers, additives in foods and drinks, cleaning compounds, and other products. Small amounts of white phosphorus have been used as rat and roach poisons and in fireworks. In the past, white phosphorus was used to make matches, but another chemical with fewer harmful health effects has since replaced it. In the military, white phosphorus is used in ammunitions such as mortar and artillery shells, and grenades.

IN THE ENVIRONMENT [3]

- White phosphorus can enter the environment when it is made, used in manufacturing or by the military, or accidentally spilled during transport and storage.
- It can be found in the water and bottom sediment of rivers and lakes near facilities that make or use it.
- In the air, white phosphorus reacts rapidly with oxygen to produce relatively harmless chemicals within minutes.
- In water, white phosphorus reacts with oxygen within hours or days.

White phosphorus is a colourless-to-white waxy solid, with a garlic like smell that is flammable in air and glows in the dark.

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- In water with low oxygen, white phosphorus may degrade to a highly toxic compound called phosphine, which eventually evaporates to the air and is changed to less harmful chemicals.
- White phosphorus can build up slightly in the bodies of fish that live in contaminated lakes or streams.
- In soil, white phosphorus may stick to particles and be changed within a few days to less harmful compounds.
- In deep soil or sediments with little oxygen, white phosphorus may remain unchanged for many years.

SOURCES & ROUTES OF EXPOSURE

Sources of Exposure [3]

- Breathing contaminated air near a facility that is using white phosphorus.
- Eating contaminated fish or game birds from sites containing white phosphorus.
- Drinking or swimming in water that has been contaminated with white phosphorus.
- Touching soil contaminated with white phosphorus.
- If you work in industries that use or manufacture white phosphorus or munitions containing white phosphorus.

Routes of Exposure [4]

White phosphorus can be absorbed into the body by inhalation, ingestion, or skin contact. It is unknown whether systemic exposure can occur from eye contact.

HEALTH EFFECTS [5]

Acute Effects

- Acute oral exposure to high levels of white phosphorus in humans is characterised by three stages: the first stage consists of gastrointestinal effects; the second stage is symptom-free and lasts about 2 days; the third stage consists of a rapid decline in condition with severe gastrointestinal (vomiting, abdominal cramps and pain), kidney, liver, cardiovascular, and CNS effects.
- Acute inhalation exposure has resulted in respiratory tract irritation and coughing in humans.

- Respiratory, liver, and kidney effects have been reported in animals acutely exposed to white phosphorus smoke via inhalation.
- Dermal exposure to white phosphorus in humans may result in severe burns, which are necrotic, yellowish, fluorescent under ultraviolet light, and have a garlic-like odour.
- Acute animal tests in rats and mice have shown white phosphorus to have extreme acute toxicity from oral exposure.

Chronic Effects

- Chronic exposure to white phosphorus in humans results in necrosis of the jaw, termed "phossy jaw." Progressive symptoms begin as a local inflammation or irritation and proceed to swelling, ulceration, and destruction of the jawbone with perforation to the sinus or nasal cavities and externally to the cheek.
- In one occupational study, anaemia and leukopenia were observed.
- Animal studies have reported effects on the blood from inhalation exposure to white phosphorus.
- The Reference Dose (RfD) for white phosphorus is 0.00002 milligrams per kilogram body weight per day (mg/kg/d) based on reproductive effects (parturition mortality and forelimb hair loss in rats).
- EPA has not established a Reference Concentration (RfC) for white phosphorus.
- The California Environmental Protection Agency (CalEPA) has calculated an inhalation reference exposure level of 0.00007 milligrams per cubic metre (mg/m^3) based on a route-to-route extrapolation of EPA's RfD. The CalEPA reference exposure level is a concentration at or below which adverse health effects are not likely to occur.
- ATSDR has calculated an acute inhalation minimal risk level (MRL) of 0.02 mg/m^3 for white phosphorus smoke based on respiratory effects in humans. The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure.

Reproductive/Developmental Effects

- No information is available on the reproductive or developmental effects of white phosphorus in humans.
- An animal study reported a high maternal mortality rate from oral exposure to white phosphorus.

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Cancer Risk

- No information is available on the carcinogenic effects of white phosphorus in humans or animals.
- EPA has classified white phosphorus as a Group D, not classifiable as to human carcinogenicity.

SAFETY [6]

First Aid Measures

- Inhalation: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, qualified personnel should administer oxygen. If respiration or pulse has stopped, have a trained person administer Basic Life Support (Cardio-Pulmonary Resuscitation/Automatic External Defibrillator) and CALL FOR EMERGENCY SERVICES IMMEDIATELY.
- Skin Contact: Immediately immerse contaminated areas under water. GET MEDICAL ATTENTION IMMEDIATELY. Keep contaminated area immersed in water until medical attention arrives. Remove contaminated clothing, jewellery and shoes. Discard contaminated clothing and footwear.
- Eye Contact: Immediately flush eyes with a directed stream of water for at least 15 minutes, forcibly holding eyelids apart to ensure complete irrigation of all eye and lid tissues. Washing eyes within several seconds is essential to achieve maximum effectiveness. GET MEDICAL ATTENTION IMMEDIATELY.
- Ingestion: Never give anything by mouth to an unconscious or convulsive person. If swallowed, do not induce vomiting. Give large amounts of water. If vomiting occurs spontaneously, keep airway clear. Give more water when vomiting stops. GET MEDICAL ATTENTION IMMEDIATELY.

Fires Information

- Fire Hazard: Phosphorus poses a severe fire hazard. Will ignite on exposure to air. If allowed to dry, contaminated water may ignite.
- Extinguishing Media: Use regular foam, water, wet sand or earth. Do not use alkaline-based extinguishing agents.
- Fire Fighting: Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Do not scatter spilled material with high-pressure water streams.

Avoid inhalation of material or combustion by-products. Wear NIOSH approved positive-pressure self-contained breathing apparatus operated in demand mode.

- Flash Point: Spontaneously flammable
- Autoignition Temperature: 86 F (30 C)
- Hazardous Combustion Products: Phosphorus pentoxide, Oxides of phosphorus

Exposure Controls & Personal Protection

Engineering Controls

- Use closed systems when possible.
- General or local exhaust ventilation and other forms of engineering controls are the preferred means for controlling exposures.
- Ensure compliance with applicable exposure limits.

Personal Protective Equipment

The following personal protective equipment is recommended when handling white phosphorus:

- Eye Protection: Wear splash resistant safety goggles with a face shield. Provide an emergency eye wash fountain and quick drench shower in the immediate work area. A quick drench tank should be used if feasible.
- Skin and Body Protection: Wear chemical resistant clothing and rubber boots when potential for contact with the material exists. In certain situations, a full body suit with hood and boots may provide short-term protection.
- Hand Protection: Wear appropriate chemical resistant gloves.
- Protective Material Types: Best Nitty Gritty(R), Aluminised Kevlar(R)
- Respiratory Protection: Supplied air is required unless there is no phosphine gas or phosphorus pentoxide present. A NIOSH approved respirator with acid gas cartridges/N95 filters cartridges may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits, or when symptoms have been observed that are indicative of overexposure. A respiratory protection program that meets 29 CFR1910.134 must be followed whenever workplace conditions warrant use of a respirator.

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REGULATION [3,7]

United States

EPA: The Environmental Protection Agency has listed white phosphorus as a Hazardous Air Pollutant. The EPA requires that spills or accidental releases into the environment of 1 pound or more of white phosphorus be reported to the EPA.

The National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) have all set the inhalation exposure limit for white phosphorus in the workplace during an 8-hour workday at 0.1 milligram of white phosphorus per cubic metre of air (0.1 mg/m^3).

Australia

Safe Work Australia: Safe Work Australia has set an 8-hour Time Weighted Average (TWA) concentration of 0.1 mg/m^3

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In a New Zealand estuary, I closed my eyes and floated. It turned out the water was toxic

2021-07-13

For most of those of us who swim, swimming is not something we think about: it is something we do.

I learned to swim in the sea, as some of us did in Aotearoa New Zealand in the early 1980s, walking down to the beach with my Auckland primary school. One of my earliest memories is of graduating to the "heads under" group and of sucking salt from my hair.

Later, my family's regular summer spot was a swimming hole in the river running through our Wairarapa farm, where occasionally I persuaded our old farm horse to swim with me. These days I swim with my own children. We go most often to the beautiful, bracingly chilly sea off the south coast of Wellington, where the summer water temperature sits around 16C.

But over recent years, as a result of a number of reports on the state of our waters, the word "swimmable" has entered our collective vocabulary. Our waters have been damaged by a long history of land conversion for cities and agriculture, and now by run-off and reduced water flow from newly intensive farming practices and more frequent droughts. Which of our rivers and lakes are still swimmable? How many of our beaches? How many are not?

The New Zealand government now publishes a website called Can I Swim Here? This past summer, although the beaches around Wellington were generally fine, not a single river or lake in the wider region where my family and I live was deemed safe for immersion of the human body.

Back in 2017, after a particularly grim report on our waters appeared, accompanied at that point by little sign of collective action, I decided to drive from Wellington to Auckland over a long weekend and swim in as many places, and in as many ways, as I could. I wanted to remember why it was we swam in the first place, and to reclaim why it seemed to matter.

"Wild swimming" isn't really a term used in Aotearoa, but that was clearly what I was doing, leaping out of the car to take a dip in a small rural creek, and skinny-dipping below sandstone cliffs in pristine water at Ototoka. I had a wonderful early morning swim with a childhood friend in the Tokomaru River in the Manawatū. We were almost out before we were in, our skin humming. I swam across a small lake, clearing weed away from my face at each stroke.

Which of our rivers and lakes are still swimmable? How many of our beaches? How many are not?

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And I swam in a tidal estuary at Mōkau on the upper Taranaki Bight, lying on my back, toes poking out, hands fluttering like vestigial wings, and let myself drift, water lapping around my ears. For a while I closed my eyes, letting the tide carry me, feeling the press of the water's echoey breath. As the minutes stretched, the water seemed to enter my body, my limbs becoming liquid.

Often, it was impossible to tell anything was wrong. But then it turned out where I had swum with my friend was "Code Red". There was an E coli warning in place: dangerous levels of animal and/or human faeces in the water. Shit. In the lake, there was the intermittent risk of toxic algae from farm run-off. By the end of my journey, I had developed a urinary tract infection. Even if not directly attributable to the toxicity of the water I had chosen to swim in, it felt like my body's physical response.

That was when I first began to properly understand, to feel in my body, what it might mean for the environment to be damaged enough to endanger us.

My determination to swim anyway was, I now think, partly a refusal to let that be how it would be, even here, in this country, the water already too damaged to bother. It was a refusal to accept and simply stay home on dry land. But it was also an attempt to translate backwards from abstractions such as counting rivers by length or by swimmability, or abstract discussions of "the climate crisis". It was an attempt to put my whole body into it. Swimming felt like a form of animal engagement and involvement – of necessary immersion.

To explore what it means to swim is also to ask what is at stake in a place becoming unswimmable – for other beings, too, who also need water to live. And for waters themselves. In Māori understanding, all water has mauri, life force. Some waters such as ngā awa, rivers, are ancestors. A recent legal settlement acknowledged the legal personhood of the Whanganui river.

By the time I finished that first swimming journey, I had come to see swimming not just as a bracketed, pleasurable summery activity it would be a shame to lose, but as one way we experience ourselves as part of this Earth, with its seas and tributaries, its veins of rivers and lakes. And the brevity of the time we have.

theguardian.com, 13 July 2021

https://www.theguardian.com

Manatees are dying in record numbers in Florida

2021-07-13

A record-breaking number of manatees have died this year in Florida's waters, mostly due to starvation, according to recent news reports.

Between Jan. 1 and July 2, 841 manatees died near and off the coast of Florida, according to a preliminary mortality report published by the Florida Fish and Wildlife Conservation Commission. Florida's previous deadliest year for manatees was 2013, when 830 manatees died, mostly from exposure to toxins from a harmful algal bloom known as red tide, according to The Associated Press.

The main cause of this year's die-off, however, is starvation, according to the Florida Fish and Wildlife Conservation Commission. Most of these manatees died during the colder months, when they migrated to and through the Indian River Lagoon, a group of three lagoons located southeast of Orlando, on Florida's east coast, where most seagrass had died out.LAY SOUND

The loss of seagrass, a food that manatees rely on to survive, is likely a result of increasing pollution in Florida's waters; fertilizer runoff and sewage leaks have led to increased levels of nitrogen and phosphorus in the waters, which, in turn, can drive algal blooms, according to TC Palm, a local news site.

Since 2011, persistent algal blooms have reduced the clarity of the water, which has led to less sunlight reaching the seagrass beds; seagrass, like many plants, needs sunlight to survive, according to the Florida Fish and Wildlife Conservation Commission. The commission is now working with other organizations, universities and government agencies to help restore the habitat.

In March, the Florida Fish and Wildlife Conservation Commission declared an "unusual mortality event" for the manatees — a designation that allows the federal government to work with the state government and nonprofit organizations to help the manatees and figure out the cause of the die-off, according to TC Palm.

"The long-term health effects of prolonged starvation in manatees that survived the Atlantic event to this point are not yet known," the commission said.

But as the weather got warmer, and manatees traveled elsewhere in Florida to forage for food, the "numbers of malnourished carcasses and

Florida's previous deadliest year for manatees was 2013, when 830 manatees died, mostly from exposure to toxins from a harmful algal bloom known as red tide, according to The Associated Press.

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manatees in need of rescue decreased," according to the Florida Fish and Wildlife Conservation Commission. In June, the leading cause of death in manatees became boat strikes. So far this year, 63 manatees have been killed by boats, according to TC Palm.

Previously known threats to manatees, including boat strikes, need to "continue to be recognized as a concern for the population," according to the commission.

Manatees (Trichechus manatus) were once classified as endangered by the U.S. Fish and Wildlife (FWS). There were only a few hundred remaining in the 1970s, according to the FWS. Thanks to conservation efforts, their numbers rebounded, and they were upgraded to "threatened" status in 2017, according to the FWS. About 6,300 manatees currently live in Florida waters, according to The Associated Press.

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livescience.com, 13 July 2021

https://www.livescience.com

Just days before Olympics, Tokyo's outdoor swimming venue stinks

2021-07-14

In less than two weeks, Olympic swimmers will dive into Tokyo Bay to compete in the triathlon. For residents who live near the shore, that's an unappealing thought because, despite months of efforts to clean up the water, the bay stinks.

Known for its shoreline of gleaming skyscrapers and iconic Rainbow Bridge, the "futuristic landscape" was selected "at the strong request of international sporting organizations," according to the Tokyo 2020 Organizing Committee. But in the run-up to the games, problems began to emerge.

In August 2019 a test for the swimming part of the Paratriathlon was canceled after E. coli bacteria was found in the water at more than twice the limit set by the International Triathlon Union, now called World Triathlon. As one athlete put it, the venue "smelled like a toilet," the Asahi newspaper reported. Since then, the host city has taken drastic steps to try to repair its tarnished image.

But in the run-up to the games, problems began to emerge.

It dumped 22,200 cubic meters of sand into the bay to create an environment for organisms that help clean the water. And it's designed three-layer polyester screens to protect the Olympic swimming venues from E. coli. On top of that the city was already building huge storage tanks to capture flood runoff, so that it can be treated before reaching the sea.

Koichi Yajima, director at Planning and Promotion Division of Bureau of Olympic and Paralympic Games Tokyo 2020 Preparation, said the screen system has been tested since 2018 and will provide a secure environment to hold the games.

Yet in recent weeks, a pungent smell has been wafting in from the water.

"As residents we should raise our own awareness," said Mariko Watanabe, who said she's been bothered by the smell and effluent in the Bay and canals since she moved to the waterside six years ago. "The water should be an environment where children can play safely."

Some scientists are concerned that the city's proposed clean-up measures aren't enough.

Yukio Koibuchi, a former associate professor at Tokyo University's Graduate School of Frontier Sciences, says the proposed measures "won't reduce the inflow of E. coli much" because the area is a part of a tidal river and the bacteria could flow underneath the screens.

Mixed Sewage

The problem is that the world's largest metropolis doesn't have separate drainage systems for rainwater and sewage. So the waste water and sewage from 30 million residents combined with runoff that feeds seven rivers and dozens of subterranean streams and canals all has to be treated before entering the bay.

Tokyo suffers from typhoons and other extreme weather which cause floods that can overwhelm the treatment system. To avoid damage from the floodwaters during days of extreme rainfall, untreated sewerage gets flushed directly into the bay.

Mostly it stays there. The bay is classified as a drowned river estuary, and while it covers an area of 960 square kilometers, it has a relatively narrow opening to the sea and an average depth of just 15 meters. Its salinity is only about 1%, according to research by Koibuchi and others, which means 60% of the water is from the rivers and drains of the city.

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Like other old cities including London and New York, the sewers developed over more than a century. "The combined sewer system was introduced in Tokyo in the early 1900s," according to Tateki Kanno, director of the planning and coordinating division of Tokyo's Bureau of Sewerage.

Rapid population growth has stretched the city's ability to keep up. The Shibaura treatment plant, which collects contaminated water from across the business center and releases into Tokyo Bay, was built in 1931, when Tokyo's population was less than half what it is today.

"Tokyo has the highest effluent load in the world," said Shigeru Enomoto, a councilor of neighboring Minato ward who has been fighting to clean up the bay for more than 15 years. "The Olympics has highlighted the long-standing issue of pollution." He has called for the government to build separate systems for sewage and rainwater.

The Tokyo Bureau of Sewerage estimates that would cost at least 10 trillion yen and take over 100 years to do that. "Conversion is not a realistic solution," said Kanno. Instead the bureau has been building storage tanks to capture and hold waste water during floods until treatment plants are able to process it.

As a result of installing 1.5 million cubic meters of capacity, the number of times waste water flows directly into ocean has fallen to 14 times a year from 56, according to the Sewerage Bureau. The city plans to add 200,000 cubic meters more to meet regulations that will be tightened in fiscal 2024.

Dirty Cities

For the triathlon and marathon swimmers who begin their events on July 26, water quality has become one of the hazards of the event, and not just in Tokyo.

"Tokyo Bay is not clean by any means," said Taro Shiraro, a triathlete who's been competing in races over 30 years. But he said it isn't as bad as some places where competitions are held. "Triathlon games are increasingly held in urban areas. Not many of them are clean."

Beyond the games, concerns remain about harmful levels of bacteria. By June last year, the Tokyo Metropolitan Government spent 120 million yen to spread bargeloads of sand from Kozushima Island 170 kilometers away to "create a comfortable environment for aquatic organisms" and "improve the water quality," said Tomoyuki Higuchi, a director of planning and construction in Tokyo's Bureau of Port and Harbor.

Higuchi says small organisms such as sand worms and Spionidaes are increasing, but the water quality hasn't become visibly cleaner yet. "The project will bring a long-term benefit," he said.

Enomoto conducted an experiment last year on the sediment and said methane released at low tide from sludge below the new sand bed is one of the factors contributing to the bad smell. But he said the presence of bacteria remains a key concern. "E. coli is just an indicator bacterium which is relatively weak," he said. "If the presence of E. coli is confirmed, stronger ones like dysentery or typhoid may be there too."

Still, not everyone is in favor of separating the sewage system. Kenji Morita, director of non-profit "Association for Shore Environment Creation" says overtreatment of the sewage could reduce the supply of nutrients that seaweed and shellfish need to grow. "The sea is not a swimming pool, but a part of the natural environment," he said. "It's vital to aim for regeneration and preservation of the original environment and use it appropriately."

bloomberg.com, 14 July 2021

https://www.bloomberg.com

Cats and dogs get COVID-19 from their owners at extremely high rates

2021-07-09

Pet cats and dogs often catch COVID-19 from their owners, a new study suggests.

The study researchers found that, among the pets of people who had recovered from COVID-19, about two-thirds of cats and more than 40% of dogs had antibodies against the coronavirus that causes COVID-19, meaning the pets had been infected with the virus in the past. In particular, cats that slept in their owners' beds had a high risk of catching the disease.

Although researchers have previously documented a few cases of pets catching COVID-19 from their owners, they didn't know exactly how common this human-to-pet transmission was.

"If someone has COVID-19, there is a surprisingly high chance they will pass it on to their pet," study co-author Dr. Dorothee Bienzle, a professor of veterinary pathology at the University of Guelph in Ontario, Canada, said in a statement. The authors recommend that people with COVID-19 keep their distance from their pets, and "keep [pets] out of your bedroom," Bienzle said.

The authors recommend that people with COVID-19 keep their distance from their pets, and "keep [pets] out of your bedroom," Bienzle said.

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The study will be presented this week at this year's virtual European Congress of Clinical Microbiology & Infectious Diseases (ECCMID 2021) and has not yet been published in a peer-reviewed journal.

For the study, the researchers tested 48 cats and 54 dogs, from 77 households, for antibodies against the novel coronavirus. (Owners in all of the 77 households had previously tested positive for COVID-19.) Owners were also asked about their interactions with their pets, including whether they kissed their pets or allowed the pets to sleep on their bed.

The researchers also tested 75 dogs and cats housed in animal shelters, and 75 stray cats that were seen at a low-cost veterinary clinic, for antibodies against the novel coronavirus.

They found that 67% of the pet cats (32 out of 48 cats) tested positive for COVID-19 antibodies, as did 43% of the pet dogs (23 out of 54 dogs). In contrast, only 9% of the cats and dogs in the animal shelters, and 3% of stray cats, tested positive for COVID-19 antibodies.

This finding suggests that COVID-19 is most likely spreading from people to pets, rather than the other way around, given that strays and shelter animals likely have less contact with humans than pets do.

Fortunately, most pets that had coronavirus antibodies were asymptomatic or had mild symptoms. About 20% of the 54 pet dogs showed symptoms around the time their owners got sick, including reduced energy levels, loss of appetite and cough; but these symptoms cleared up quickly, the researchers said. About 27% of the 48 pet cats had symptoms, including runny nose and difficulty breathing. Three of the feline cases, or 6%, were severe.

Dogs that had close contact with their owners or slept on their owner's beds were no more likely to catch COVID-19 than dogs that didn't have this type of contact. However, cats that spent more time with their owners or slept on their owner's bed were more likely to catch COVID-19, as compared with the perhaps more aloof cats.

Cats appear to be more susceptible to COVID-19 than dogs. This may be because the virus binds more easily to the receptors on the surface of cats' cells compared with dogs' cells, the authors said. In addition, cats may be more likely to sleep near their owners' faces compared with dogs, they said.

No data suggests that pets can pass COVID-19 back to people, and the risk of this happening is low, according to the Centers for Disease Control and Prevention (CDC).

But since the possibility of pet-to-human transmission can't be ruled out, it's all the more reason to isolate pets from people sick with COVID-19, the authors said. Pets that test positive for COVID-19 should also be kept away from other people and pets, according to the CDC.

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https://www.livescience.com

Native water rat, rakali, under threat from Brisbane southside residential development

2021-07-15

A draft plan for more apartments and industry in a southside Brisbane suburb may put the home of one of Australia's most elusive aquatic creatures at risk, a freshwater scientist says.

Key points:

- A secretive native water rat lives in a southside Brisbane creek
- A council plan to increase suburban density may affect the creek, one scientist says
- That could put the rat's home at risk

Brisbane City Council's draft neighbourhood plan for the suburbs of Moorooka, Salisbury and Nathan proposes to increase industrial, commercial, and residential development in parts of the suburbs.

A secretive creature

But freshwater scientist and long-term Salisbury resident Alisha Steward has raised concerns the proposed density increase could impact upon creeks flowing through the suburbs.

That includes Rocky Waterholes Creek, which is home to a surprising urban population of Australian native water rats, spotted by locals on more than one occasion.

"You could almost call it the Aussie otter," Dr Steward told ABC Radio Brisbane.

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"You could almost call it the Aussie otter," Dr Steward told ABC Radio Brisbane.

"It's just a beautiful creature, it's got water-repellent fur, it's got partially webbed hind feet and it's quite large, it's about the size of a platypus."

The stocky, water-loving rat is a far cry from the typical brown rat living in waterways across much of eastern Australia in its own territories.

The native water rat is also known as the rakali, an Indigenous name.

A top-flight predator, the rakali is easily identified by its white-tipped tail and, as an aquatic rodent, spends most of its time in and around creeks, living off crustaceans, insects and fish.

"It's found throughout Australia, really, but it's a very secretive creature so not many people have seen one," Dr Steward said.

A suburban home

Dr Steward said, despite the existing industrial precincts around the creek, the rakali must have found a good mix of habitat, shelter, and food to have such a strong population.

Water samples showed a strong mix of insects and bugs and even freshwater prawns, she said.

Dr Steward said she was concerned the council's proposed suburban infill could create 'urban stream syndrome'.

"We see more and more development gobbling up backyards, gardens, [and] these areas are really important for the filtration of rainwater," Dr Steward said.

"You can imagine rain falling down and it's hitting the garden soaking in … and getting into the groundwater.

"But when you get … more roofs and driveways, that's all capturing that water, creating overland flow and we're getting these really flash flows into the creek.

"If we're getting an increase in all these hard surfaces that rainwater can't get through, then we're really going to see impacts with the creek."

Brisbane City Council Deputy Mayor and city planning chair Krista Adams said ecologically significant areas within the draft plan were highlighted, including Rocky Waterholes Creek.

"Once the latest round of community feedback is received, technical studies and targeted investigations, including into stormwater, will be completed," Cr Adams said.

"The findings of these environment assessments and community feedback will be considered during the preparation of the neighbourhood plan."

Public consultation on the plan is open until July 26.

abc.net.au, 15 July 2021

https://www.abc.net.au

Scientists may have cracked the mystery of da Vinci's DNA

2021-07-07

Leonardo da Vinci — the great Renaissance artist, inventor and anatomist — has 14 living male relatives, a new analysis of his family tree reveals. The new family tree could one day help researchers determine if bones interred in a French chapel belong to the Italian genius.

Historians Alessandro Vezzosi and Agnese Sabato have spent more than a decade tracing the genealogy of the famed "Mona Lisa" painter. Their map stretches across 690 years, 21 generations and five family branches, and will be vital in helping anthropologists sequence the DNA of da Vinci by sequencing the DNA of his descendants, the researchers say.

PLAY SOUND

Beyond establishing the identity of his possible remains, sequencing the artist's DNA could also give scientists a better understanding of "his extraordinary talents — notably, his visual acuity, through genetic associations," claim representatives from the Leonardo Da Vinci DNA Project, an initiative that aims to use the genetic information to create 3D images of da Vinci through a process called DNA phenotyping.

Da Vinci was a painter, architect, inventor, anatomist, engineer and scientist. Primarily self-educated, he filled dozens of secret notebooks with fanciful inventions and anatomical observations. To accompany famous sketches such as the "Virtruvian Man", da Vinci would write messages coded into his own shorthand, mirrored back to front to hide his studies from prying eyes. Along with detailed drawings of human anatomy, taken from observations of dissected cadavers, his notebooks contain designs for bicycles, helicopters, tanks and airplanes.

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In a new study, Vezzosi and Sabato used historical documents from archives alongside direct accounts from surviving descendants to trace the five branches of the da Vinci family tree. According to the historians, Leonardo was part of the sixth generation of da Vincis.

Researching da Vinci's family history is difficult because only one of his parents can be properly traced. Born out of wedlock in the Tuscan town of Anchiano, Leonardo da Vinci was the son of Florentine lawyer Ser Piero da Vinci and a peasant woman named Caterina. Research by Martin Kemp, an art historian at Oxford University, suggests that Caterina was a 15-year-old orphan at the time of da Vinci's birth, Live Science previously reported. At age 5, the young da Vinci was taken to his family estate in the town of Vinci (from which his family took their surname) to live with his grandparents.

When da Vinci died on May 2, 1519, at age 67, he had no known children, and his remains were lost, meaning there was no reliable DNA to analyze. As a result, parts of his ancestry have become shrouded in mystery.

The new family tree could one day help researchers determine if bones interred in a French chapel belong to the Italian genius.

Leonardo's original burial was recorded at the chapel of Saint-Florentin at the Chateau d'Amboise, a manor house in France's Loire Valley. The chapel was left to ruin after the French Revolution and later demolished. Contemporaneous accounts allege that a full skeleton was exhumed from the site and moved to the nearby Saint-Hubert chapel, but whether or not they are actually Leonardo's bones remains a mystery.

The new family tree, which starts in 1331 with family patriarch Michele, revealed 14 living relatives with a wide variety of occupations, including office workers, a pastry chef, a blacksmith, an upholsterer, a porcelain seller and an artist.

The researchers will determine whether the human remains from the Loire Valley chapel belong to da Vinci by comparing the Y chromosome in those bones to the Y chromosome belonging to da Vinci's male relatives. The Y chromosome is passed from father to son and remains virtually unchanged for as long as 25 generations, according to the researchers.

In addition, finding fragments of da Vinci's genetic code could help art historians verify the authenticity of artworks, notes and journal entries supposedly created by the Italian Renaissance man by comparing his discovered DNA with DNA traces found on the pieces.

The researchers published their findings July 4 in the journal Human Evolution.

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https://www.livescience.com

New 'mirror' fabric can cool wearers by nearly 5°C

2021-07-08

While it's easy to engineer clothing that keeps you warm, it's far harder to come up with an outfit that can keep you cool on a scorching summer day. Now, researchers have designed a fabric that looks like an everyday T-shirt, but can cool the body by nearly 5°C. They say the technology, if mass produced, could help people around the world protect themselves against rising temperatures caused by climate change.

To make clothing that beats back the Sun, fashion designers typically use light-colored fabric, which reflects visible light. But another method reflects the Sun's electromagnetic radiation, including ultraviolet (UV) and near-infrared (NIR) radiation. NIR warms objects that absorb it and slowly cools them as they emit it. That cooling process, however, is stymied by our atmosphere: After being emitted from an object, NIR is often absorbed by nearby water molecules, heating up the surrounding air.

To speed up the cooling process, researchers are turning to mid-infrared radiation (MIR), a type of IR with longer wavelengths. Instead of being absorbed by molecules in the surrounding air, MIR energy goes directly into space, cooling both the objects and their surroundings. This technique is known as radiative cooling, and engineers have used it over the past decade to design roofs, plastic films, wood, and ultra-white paints.

Human skin, unlike many of the clothes we wear, naturally emits MIR. In 2017, Stanford University researchers designed a fabric that lets MIR from the human body pass directly through it, cooling the wearer by about 3° C. But to work, the fabric had to be very thin—only 45 micrometers, or about one-third the thickness of a lightweight linen dress shirt. That led some researchers to question its durability.

To design a thicker fabric, engineers Ma Yaoguang of Zhejiang University and Tao Guangming of Huazhong University of Science and Technology took a different approach. Rather than letting MIR from the skin pass straight through their fabric, they and colleagues designed a textile that used chemical bonds to absorb body heat and re-emit its energy into space as MIR. The 550 micrometer fabric—made of a polylactic acid and synthetic fiber blend with titanium dioxide nanoparticles scattered throughout—also reflects UV, visible, and NIR light, further cooling the wearer. Even though it looks like a regular shirt, "optically, it's a mirror," Tao says.

Now, researchers have designed a fabric that looks like an everyday T-shirt, but can cool the body by nearly 5°C.

To test their creation, the researchers assembled a snug-fitting vest, with one half made of their fabric and the other made of white cotton of about the same thickness. A graduate student donned the vest and sat in a lawn chair in direct sunlight for 1 hour. When the researchers measured his skin temperature, the side under the new fabric was almost 5° C cooler than the side under the cotton, they report today in Science. To an infrared camera, the contrast was clearly visible, and Tao says the student could feel the temperature difference.

"This is all interesting," says Yi Cui, the Stanford materials scientist who led the previous work and whose lab has continued working on mid-IR transparent fabrics. But he adds that, because MIR-emitting technology has so far been used on stationary surfaces that constantly face the sky, the authors of the new work should also measure how well their fabric cools when people are standing or walking. He also wonders whether the fabric works as well when it is loosely fitted, since the cooling element relies on its close contact with the skin.

Evelyn Wang, a mechanical engineer at the Massachusetts Institute of Technology, shares some of Cui's concerns. But she adds that the work speaks to speedy progress in the area of radiative cooling. "This kind of approach has advantages because it can enable a use of a broader range of materials and feel much more like cotton, which is important for the user."

Ma and Tao are now reaching out to textile manufacturers and clothing companies to try to get their fabric on shelves. They say the nanomaterial-infused fabric should add only about 10% to typical clothing manufacturing costs. "We can make it with mass production, which means everybody can get a T-shirt … and the cost is basically the same as their old stuff," Ma says. "It can benefit everybody."

sciencemag.org, 8 July 2021

https://www.sciencemag.org

After being used by humans, metham-phetamine enters waterways through sewage systems and discharges from wastewater treatment plants.

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Fish get addicted to meth in polluted rivers, go through withdrawal

2021-07-07

Fish can get hooked on meth that washes into their freshwater homes, to the point that they actively seek out the stimulant, a new study suggests.

After being used by humans, methamphetamine enters waterways through sewage systems and discharges from wastewater treatment plants. "Where methamphetamine users are, there is also methamphetamine pollution of freshwaters," first author Pavel Horký, an associate professor and behavioral ecologist at the Czech University of Life Sciences Prague, told Live Science in an email.

Meth pollutes rivers all over the world, with concentrations of the drug ranging from a few nanograms to dozens of micrograms per liter of water, according to reports in the journals Chemosphere and Water. Given the global prevalence of meth in waterways, Horký and his colleagues wondered whether fish might get hooked on these small doses of the drug.

PLAY SOUND

The team's new laboratory study, published Tuesday (July 6) in the Journal of Experimental Biology, suggests that yes, even minuscule amounts of methamphetamine could be enough to cause addiction in freshwater fish, the team concluded.

That said, an expert told Live Science that, even though the fish in the study sought out meth-tainted water, that may not be enough evidence to say they are truly "addicted."

"I'm not sure you can truly say these fish are addicted to methamphetamine, but they certainly show a preference for the compound … which they shouldn't, really," said Gabriel Bossé, a postdoctoral research fellow at the University of Utah who was not involved in the study; Bossé uses zebrafish as a model to study complex brain disorders and recently developed a technique to study opioid-seeking behaviors in the fish.

In regards to the new research, "it seems that the preference for meth dies down after just a few days," whereas if the fish were truly addicted, he'd expect that preference to persist over a longer period of time, he said. "Whether you call it addiction or not, you can argue, but it's clear that methamphetamine changed how these animals behave," and those effects

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could potentially hinder their ability to find food, avoid predators and reproduce in the wild, Bossé noted.

In the new study, the team specifically focused on brown trout (Salmo trutta), which are native to Europe, western Asia and northern Africa and have been introduced to every continent except Antarctica, Horký said. The researchers placed 60 trout in a drug-free holding tank and another 60 in a tank laced with 1 microgram of meth per liter of water.

The researchers had the latter group of fish soak in the meth-tainted water for two months — a step meant to simulate the effects of persistent drug exposure that might occur in a polluted river. The researchers then transferred the drugged fish into a clean tank for 10 days; if the trout had grown dependent on meth, they would begin to show symptoms of withdrawal after losing access to the drug, the team theorized.

To test for these withdrawal symptoms, the team devised an experiment where fish could choose between swimming in clean water or water with trace amounts of meth; the tank is designed such that the two streams of water don't mix but the fish can still swim between them. When previously exposed fish showed a preference for the meth-tainted water in the experiment, that was taken as a sign of addiction to the drug, Horký told Live Science.

The team ran select fish through this experiment on the second, fourth, sixth, eighth and 10th days after they'd been moved to the drug-free tank; they also ran drug-free fish through the same experiment, as a point of comparison. They found that, in the first four days after the tank swap, the meth-exposed fish showed a stronger preference for drugged water, compared with the fish that had not been exposed to meth. This difference waned the more time the exposed fish spent in the drug-free tank.

The researchers also noted that, in general, the meth-exposed fish became somewhat sedentary in these first four days of withdrawal, while the drug-free fish swam about as usual. This lack of movement hinted that the fish were stressed out due to their meth withdrawal, the authors suggested; scientists have seen similar behavior in zebrafish that were experiencing withdrawal from opioids, according to a 2017 report by Bossé published in the journal Behavioural Brain Research.

To get better insight into these behavioral changes, the team took samples of the fishes' brain tissue and screened them for both methamphetamine and amphetamine, a metabolic byproduct of the drug.

They found that "there were differences in concentration of amphetamine and methamphetamine that were shown to be related to changes in behavior," Horký said. The amount of amphetamine in the brain, which would indicate a past exposure to meth, correlated with the subdued swimming behavior seen in the trout experiencing withdrawal. Conversely, methamphetamine appeared in the brains of fish that chose to swim in the drugged water during the behavioral experiment; this acute exposure correlated with an uptick in swimming, again hinting that the meth offered relief from withdrawal in addicted fish.

Taken together, these results suggest that, in the wild, brown trout could become addicted to trace amounts of meth in rivers and potentially congregate in areas where the drug accumulates, the authors reported. Such "unnatural attraction to one area" could not only disrupt the fishes' migratory patterns but also undermine their success in foraging for food or finding mates, they wrote.

But again, while Bossé agrees that meth exposure could undermine the fishes' survival, he's not fully convinced the animals are addicted to the drug. The authors could strengthen their case with slight tweaks to their current experiment, he noted.

Firstly, they could allow the fish more time to explore the tank with a meth-tainted section; given hours, instead of minutes, as in the current study, the fish might learn where the meth can be accessed and show more persistant drug-seeking behavior. Their preference for the meth-tainted water could even be tested over several days, to see if they consistently gravitate to the contaminated water after being denied access to the drug, he said.

In addition, the team could do additional tests to show the animals are truly in a stressed-out, withdrawal state; for example, they could measure the animals' cortisol levels and run them through formal stress tests, Bossé said. With zebrafish, these stress tests include observing what the fish do when placed in unfamiliar tanks or tanks with one darkened side, which the fish prefer, and one brightly-lit side.

In any case, since the new study was conducted in a laboratory setting, the team still needs to investigate whether the observed patterns of addiction and withdrawal occur in wild fish populations, too, Horký said. There's also the question of how meth mingles with other contaminants in the water, including other drugs, like antidepressants, and how all these substances collectively mess with fish behavior, he noted.

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"There are a lot of contaminants of emerging concern — not only illicit drugs, but also standard prescription medicines, like antidepressants," Horký said.

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Dinosaurs may have lived in the Arctic year-round

2021-06-25

Alaska is known today for its brown and black bears, but about 70 million years ago, dinosaurs likely called the land home. A new study suggests at least half a dozen species, including some tyrannosaurs, lived in the Arctic year-round, The Guardian reports. Researchers found fossils of very young dinosaurs in northern Alaska, suggesting the creatures were permanent residents of the area and nested there, they write this week in Current Biology. Though dinosaur fossils have been found in the Arctic before, no one knew whether they lived there seasonally or full time. Scientists say the new study might answer that question—while raising a whole host of new ones, including how the dinosaurs were able to tolerate potentially brutal Arctic winters.~ssciencemag.org, 25 June 2021

https://www.sciencemag.org

Though dinosaur fossils have been found in the Arctic before, no one knew whether they lived there seasonally or full time.

Elusive glass octopus spotted in the remote Pacific Ocean

2021-07-14

This rarely seen glass octopus bared all recently — even a view of its innards — when an underwater robot filmed it gracefully soaring through the deep waters of the Central Pacific Ocean.

Marine biologists spotted the elusive glass octopus (Vitreledonella richardi) during a 34-day expedition off the remote Phoenix Islands, an archipelago located more than 3,200 miles (5,100 kilometers) northeast of Sydney, Australia.

Like other "glass" creatures, such as glass frogs and certain comb jellies, glass octopuses are almost completely transparent, with only their cylindrical eyes, optic nerve and digestive tract appearing opaque. The expedition crew reported two encounters with the glass octopus — an impressive count given that previously there was such limited footage of

these clear cephalopods, scientists had to learn about them by studying chunks of them in the gut contents of their predators.PLAY SOUND

Glass octopuses weren't discovered until 1918. Little is known about these cephalopods, except that they live in tropical and subtropical areas in the deep ocean in the mesopelagic, or twilight zone, 656 to 3,280 feet (200 to 1,000 meters) below the surface, and the bathypelagic, or midnight zone, 3,280 to 9,800 feet (1,000 to 3,000 m) below the surface, according to the International Union for Conservation of Nature.

Glass octopuses' cylindrical eye shape may have evolved to minimize the silhouette of the creatures' eyes when seen from below, "and is part of the animal's camouflage strategy," according to a 1992 report in the Journal of the Marine Biological Association of the United Kingdom.

The glass octopus was spotted by an expedition aboard the research vessel Falkor, run by the Schmidt Ocean Institute, a nonprofit operating foundation co-founded by Wendy and Eric Schmidt, the former CEO of Google. Scientists from Boston University and the Woods Hole Oceanographic Institution also participated in the expedition.

During the expedition, which ended July 8, a crew of marine scientists discovered a handful of what are likely newfound marine animals on nine previously unexplored submarine mountains known as seamounts. The team also completed high-resolution seafloor mapping of more than 11,500 square miles (30,000 square km) around the archipelago and video recordings of five additional seamounts filmed by the underwater robot SuBastian, according to a statement.

SuBastian also snagged footage of a whale shark (the largest living fish in the world) and a long-legged crab stealing a fish from another crab.

The expedition sent SuBastian on 21 dives, enabling the robot to record more than 182 hours on the seafloor. Seven of those dives took place in the U.S. Pacific Remote Islands Marine National Monument (PRIMNM), which was established in 2009 and expanded in 2014. The expedition allowed scientists to document the monument, where marine animals are protected. The Falkor also revisited parts of the Phoenix Islands that its scientists had studied in 2017, which allowed researchers to collect data that will help them learn how the entire ecosystem and seamounts' habitats are linked together.

"The Ocean holds wonders and promises we haven't even imagined, much less discovered," Wendy Schmidt said in the statement. "Expeditions like

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these teach us why we need to increase our efforts to restore and better understand marine ecosystems everywhere — because the great chain of life that begins in the ocean is critical for human health and wellbeing."

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How many atoms are in the observable universe?

2021-07-10

All matter in the universe — no matter how big, small, young or old — is made up of atoms.

Each of these building blocks consists of a positively charged nucleus, made up of protons and neutrons, and negatively charged orbiting electrons. The number of protons, neutrons and electrons an atom has determines which element it belongs to on the periodic table and influences how it reacts with other atoms around it. Everything you see around you is just a configuration of different atoms interacting with one another in unique ways.

So, if everything is made of atoms, do we know how many atoms are in the universe?

To start out "small," there are around 7 octillion, or 7x10^27 (7 followed by 27 zeros), atoms in an average human body, according to The Guardian. Given this vast sum of atoms in one person alone, you might think it would be impossible to determine how many atoms are in the entire universe. And you'd be right: Because we have no idea how large the entire universe really is, we can't find out how many atoms are within it.

However, it is possible to work out roughly how many atoms are in the observable universe — the part of the universe that we can see and study — using some cosmological assumptions and a bit of math.

The observable universe

The universe was created during the Big Bang 13.8 billion years ago. As it exploded into existence, from a single point of infinite mass and temperature, the universe began expanding outward and hasn't stopped since.

Because the universe is 13.8 billion years old and the observable universe stretches as far away from us as light can travel in the time since the universe was born, you might assume that the observable universe stretches only 13.8 billion light-years in every direction. But because the universe is constantly expanding, this isn't the case. When we observe a distant galaxy or star, what we are really seeing is where it was when it first emitted the light. But by the time the light reaches us, the galaxy or star is much farther away than it was when we saw it. Using cosmic microwave background radiation, we can work out how fast the universe is expanding, and because that rate is constant — which is currently

So, if everything is made of atoms, do we know how many atoms are in the universe?

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scientists' best guess (although some scientists think it may be slowing down) — that means that the observable universe actually stretches 46 billion light-years in all directions, according to Live Science's sister site Space.com.

But knowing how big the observable universe is doesn't tell us everything we know about how many atoms are in it. We also need to know how much matter, or stuff, is in it.

Cosmic assumptions

Matter is not the only thing in the universe, however. In fact, it makes up only about 5% of the universe, according to NASA. The rest consists of dark energy and dark matter, but because they are not made up of atoms, we don't need to worry about them for this mystery.

According to Einstein's famous E=mc^2 equation, energy and mass, or matter, are interchangeable, so it is possible for matter to be created from or transformed into energy. But on the cosmic scale of the universe, we can assume that the amount of matter created and uncreated cancel each other out. This means matter is finite, so there are the same number of atoms in the observable universe as there always have been, according to Scientific American. This is important because our picture of the observable universe is not a single snapshot in time.

According to our observations of the known universe, the physical laws that govern it are the same everywhere. Combined with the assumption that the expansion of the universe is constant, this means that, on a large scale, matter is uniformly distributed throughout the cosmos — a concept known as the cosmological principle. In other words, there are no regions of the universe that have more matter than others. This idea allows scientists to accurately estimate the number of stars and galaxies in the observable universe, which is useful because most atoms are found within stars.

Simplifying the equation

Knowing the observable universe's size and that matter is equally and finitely distributed across it makes it a lot easier to calculate the number of atoms. However, there are a few more assumptions we have to make before we break out the calculator.

First, we must assume that all atoms are contained within stars, even though they aren't. Unfortunately, we have a much less accurate idea of how many planets, moons and space rocks there are in the observable

universe compared with stars, which means it is harder to add them into the equation. But because the vast majority of atoms in the universe are contained within stars, we can get a good approximation of the number of atoms in the universe by figuring out how many atoms there are in stars and ignoring everything else.

Second, we must assume that all atoms in the universe are hydrogen atoms, even though they aren't. Hydrogen atoms account for around 90% of the total atoms in the universe, according to Los Alamos National Laboratory, and an even higher percentage of the atoms in stars, which we are focusing on. As you will see shortly, it also makes the calculations a lot simpler.

Doing the math

Now, it's finally time to do the math.

To work out the number of atoms in the observable universe, we need to know its mass, which means we have to find out how many stars there are. There are around 10^11 to 10^12 galaxies in the observable universe, and each galaxy contains between 10^11 and 10^12 stars, according to the European Space Agency. This gives us somewhere between 10^22 and 10^24 stars. For the purposes of this calculation, we can say that there are 10^23 stars in the observable universe. Of course, this is just a best guess; galaxies can range in size and number of stars, but because we can't count them individually, this will have to do for now.

On average, a star weighs around 2.2x10^32 pounds (10^32 kilograms), according to Science ABC, which means that the mass of the universe is around 2.2x10^55 pounds (10^55 kilograms). Now that we know the mass, or amount of matter, we need to see how many atoms fit into it. On average, each gram of matter has around 10^24 protons, according to Fermilab, a national laboratory for particle physics in Illinois. That means it is the same as the number of hydrogen atoms, because each hydrogen atom has only one proton (hence why we made the earlier assumption about hydrogen atoms).

This gives us 10^82 atoms in the observable universe. To put that into context, that is 10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000 atoms.

This number is only a rough guess, based on a number of approximations and assumptions. But given our current understanding of the observable universe, it is unlikely to be too far off the mark.

Editor's Note: This article was updated at 12:10 p.m. ET on July 12, 2021 to remove an extra zero from the 10^82 number.

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Why do women tend to outlive men?

2021-07-11

In the United States, the average life expectancy for women is 81 years, according to the Centers for Disease Control and Prevention (CDC). For men, it's 76 years. Around the world, women live longer, on average. So why do women tend to outlive men?

Two of the main causes are biological, said Virginia Zarulli, an associate professor of demography at the University of Southern Denmark. The first cause relates to differences in sex hormones, at least in cisgender people (people whose gender identity matches the biological sex they were assigned at birth). Cisgender women produce more estrogen and less testosterone than cisgender men do. Estrogen provides protection against a range of diseases, such as cardiovascular disease, according to a 2017 study in the journal Biology of Sex Differences.

Two of the main causes are biological, said Virginia Zarulli, an associate professor of demography at the University of Southern Denmark.

High levels of testosterone, on the other hand, have been linked to an increased risk of some diseases, such as endometrial and breast cancer in women and prostate cancer in men, according to a 2020 study in the journal Nature Medicine. Testosterone has also been linked to risky behavior and higher levels of aggression, which can increase the risk of dying at a younger age, Zarulli said.

PLAY SOUND

There's also a genetic component at play. Humans have two sex chromosomes: X and Y. Cisgender women have two X chromosomes, and cis men have an X and a Y. "If you think about that, the Y chromosome is an X chromosome with a missing leg. It's missing genetic material," Zarulli said. "Women have this double X chromosome — extra genetic material — which allows them to, for instance, have a backup plan if there is a bad mutation on one of the two X chromosomes. The other X can let them live anyway." This is the case for diseases such as hemophilia, a type of bleeding disorder, and Duchenne muscular dystrophy, which causes the muscles to progressively weaken.

This biological advantage gives women, on average, just under a year of longer life expectancy when they are young adults compared with men, according to a 2003 study published in the journal Population and Development Review on more than 11,000 Bavarian Catholic nuns and monks who lived between 1890 and 1995. In strict religious settings, men and women have similar lifestyles, and both sexes avoid risky behaviors; therefore, their difference in longevity is probably biological, Zarulli said. However, the study doesn't report on life expectancy from birth but from young adulthood, so the difference in total life expectancy is probably more. Zarulli said that biology gives women about two additional years of life, on average.

Additionally, when infants are in settings with particularly high mortality rates, such as during severe famines and epidemics and when they are enslaved, baby girls have higher survival rates than baby boys, according to a 2018 study led by Zarulli and published in the journal Proceedings of the National Academy of Sciences.

But, on average, women live four or five more years than men, Zarulli said. So what accounts for the rest of their survival advantage?

Social factors play a large role, she said. Men tend to smoke cigarettes and drink alcohol more often than women; men are nearly twice as likely to binge drink and are more likely to have had alcohol in the past 30 days, according to the CDC, and 35% of men in the world smoke compared with 6% of women, according to data from the World Bank. Women are more likely to trust in healthy nutrition and men are more likely to prefer fatty meals and eat fast food, according to a 2020 review study in the journal Advances in Clinical and Experimental Medicine. And women are 33% more likely to visit a doctor, excluding pregnancy-related care, than men are, according to a 2001 study by the CDC.

But it's impossible to completely tease apart biology and social effects to explain phenomena such as why men engage in riskier behaviors. "Both tend to influence the sex gap in life expectancy," Zarulli said. The interaction between the two is "impossible to divide," she said.

The life expectancy gap hasn't always been as wide as it is now. Detailed mortality records show that women didn't consistently live longer than men until about the start of the 20th century, according to a report from the National Bureau of Economic Research. Before then, infectious diseases ran rampant and hit both sexes fairly equally. In addition, women often died during childbirth.

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Since then, women's life expectancy hasn't always risen as much as it could. Starting in the mid-1970s, the gap between potential and observed life expectancy started to increase for women due to cigarette smoking, according to a 2011 report by the National Research Council. By 2005, women were living, on average, 2.3 years less than expected because so many women had started smoking.

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How Lego perfected the recycled plastic brick

2021-07-11

EACH YEAR, MORE than 380 million metric tons of plastic is produced worldwide. Lego is responsible for 100,000 metric tons of it. This contribution to the annual total is, of course, the result of making its classic children's toy. Lego's impact may initially appear to be a sliver of that plastic output, but it still counts. Why? That 100,000 metric tons of polymer was last year turned into 110 billion bricks.

That 100,000 metric tons of polymer was last year turned into 110 billion bricks.

What's more, the vast majority of those 110 billion bricks, as much as 80 percent, were made from acrylonitrile-butadiene-styrene, or ABS, a petroleum-based thermoplastic prized for its strength and rigidity. ABS does not like being recycled, because it loses those sturdy qualities. Such is the resilience of ABS, it takes lifetimes to break down, meaning whatever is made from the stuff will be hanging around on our planet for an awfully long time.

This is why, in 2015, after 66 years of pumping out vast quantities of unrecyclable interlocking toy bricks and perhaps sensing the impending plastic backlash, Lego announced it was putting $155 million of its huge income (2019 revenue hit $7 billion) into a new Sustainable Materials Center.

The first tangible product to come out of this center was a sugarcane-based plastic. It took the company two years to perfect this sustainable polyethylene, and it was hailed as a great success. The trouble was, due to its less-than-rigid nature, it was mainly suited to non-load-bearing lines, like trees and leaves—a tiny proportion of Lego products, around 2 percent.

Now, however, comes the main event: the humble 2 x 4 brick. Lego has moved on from bendy bioplastic to making a new prototype block that is fabricated from PET plastic from discarded bottles. It is the very first brick made from a recycled material to meet most of Lego's requirements for its standard ABS bricks.

Over the past three years, Lego's 150-strong Sustainable Materials team has tested more than 250 variations of PET materials. The resulting prototype, according to Tim Brooks, vice president of environmental responsibility at Lego, nails one of the toughest hurdles for a non-ABS brick: clutch power.

Clutch power is simply how well two joined bricks stick together. If a plastic is not rigid enough or shrinks too much in the manufacturing and molding process, the Lego blocks simply won't grip to each other properly.

"We're molding to the tolerance of about one to two microns, less than the thickness of a human hair," says Brooks. "That's incredibly precise compared to most consumer products. So the clutch is probably the number-one challenge we have. Either prototype bricks simply don't hold or you're using pliers to get them apart. To get that brick to mold effectively is hard. To go into the mold in about the consistency of toothpaste—pushing it in warm and then cooling it down – the material will shrink, you need it not to shrink too much."

The brick also needs to not only hold its shape and keep that clutch but do so over entire generations of play, because Brooks says such materials creep and change shape over time. Standard Lego bricks are tested using high and low temperatures, butter, and even fake saliva to make sure they maintain their integrity over decades of use.

With its new PET brick, however, Lego has cracked it. Well, nearly. "We need to now work on how to slightly tighten the clutch and how to add colors to the brick," says Brooks. "When we do that, we'll go through shape by shape and determine how many ABS bricks can be replaced by PET."

The key here is, out of the 3,500 or so different shapes Lego produces, the 2 x 4 brick is one of the most popular it. If the company can replace such a component with a recycled plastic version, it will have a significant impact of the environmental goal of Lego to be using fully sustainable materials in its products by 2030. "We have what we call 'high runners,'" says Brooks. For example, we know that most sets will have a 2 x 4, certainly we know pretty much every set will have a 1 x 1 dot. That is by far the most common brick that we make."

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"ABS is incredibly stiff. Very stiff, very precise, very hard. PET is less stiff, less hard, and less precise, so that's why we need to use an impact modifier with PET. That's what different here. We are using a different grade of PET with an added 'secret sauce' that we have a patent pending on. So you're looking at a PET that we're modifying to make it perform like ABS."

Gregg Beckham from the US Department of Energy's National Renewable Energy Laboratory, who, in 2018 along with Portsmouth University's John McGeehan, engineered an enzyme that digests PET, is impressed with Lego's progress.

"ABS is an amazing material. It is extremely versatile, because you can change the ratio of the A the B and the S. And depending on how you formulate it there are a very large number of versions of ABS plastic that you can make. We literally touch it every day," Beckham says. "PET, on the other hand, is challenging to formulate in a manner that has the same material properties as ABS like you would find in Lego brick. That is an exceptional polymer science challenge, for sure. This is super exciting."

As for why it has taken so many decades of plastic production to get to this point, Beckham says that while it would be nice if we could wave a magic wand and just make it happen, in many cases the task is deceptively difficult. "This is fundamental material science and engineering that needs to figure out how to meet the same types of material properties with feedstocks that are either from recycled plastic or become recyclable themselves," he says. "In the case of ABS bricks, they are neither from recycled plastics nor are they recycled at end of life. This potentially could meet both of those challenges simultaneously."

There's another benefit to the new prototype PET brick: It has a 70 percent carbon reduction compared to the virgin ABS material brick.

But, interestingly, while developing new eco plastics is ongoing, the real environmental benefits may well come from developing ways to recycle the stuff we currently can't. Stuff like ABS. "Laboratory research today is thinking about using advanced recycling approaches that are able to break down the polymers, these long chains of molecules, into their building blocks," Beckham says. "Then purify those and turn them back into either the same plastic they were at the same virgin-type plastic quality or to open-loop recycle them and turn them into something else that's of even higher value."

While this idea of recycling using chemistry to break down plastic like ABS is something that Beckham and his team are actively working, Lego has

its sights set on this target too. As does Brooks. "We've use 20 different materials today; it may be that we end up with 40 in the future. Potentially ABS could be replaced by recycled ABS when we get there," he says. "In the mid-term it will be recycled PET. We've got about 15 to 20 other materials that we're working through one by one. But recycled ABS is where we're trying to get to."

This story originally appeared on WIRED UK.

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https://www.wired.com

Why are thousands of stinging jellyfish crowding the Rhode Island coast?

2021-07-09

Thousands of jellyfish are gathering by the coast of Rhode Island, and they're not afraid to use their stingers against potential foes, according to news sources.

The jellyfish, known as Atlantic sea nettles (Chrysaora quinquecirrha), thrive in warm waters, which may partially explain the recent population boom over the past month, the Rhode Island Division of Fish and Wildlife Outdoor Education (RIDEM) posted on Facebook. After all, June 2021 was the hottest June on record in North America, according to the European Union's Copernicus program, Live Science reported.

Even so, scientists are puzzled over the cause of the spike. The jellyfish swarms are popping up at a coastal lagoon known as Ninigret Pond and a saltwater lagoon estuary called Green Hill Pond, near the coast. "Their high abundance in the ponds this summer is not fully understood," RIDEM wrote in the post, adding that "their numbers are expected to decline as the summer goes on."PLAY SOUND

Swimmers would be wise to avoid the jellies, the RIDEM noted. "Although their sting is not fatal (unless there is a severe allergic reaction), it can cause moderate discomfort and itchy welts," RIDEM representatives wrote in the post.

If you are stung by an Atlantic sea nettle, there are some steps you should take, the RIDEM noted. First, remove any visible tentacles from the affected area with a gloved hand or plastic bag. Then, rinse the sting with vinegar, store-bought sting spray or (in a pinch) saltwater, but not freshwater, "as this can worsen the sting," RIDEM representatives wrote. Moreover,

"Their high abundance in the ponds this summer is not fully understood," RIDEM wrote in the post, adding that "their numbers are expected to decline as the summer goes on."

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because heat can inactivate the venom, the RIDEM recommended applying a hot pack or hot water to the sting. After that, "an ice pack and hydrocortisone cream can be applied to help with discomfort," the RIDEM noted, adding that you should seek professional medical care if symptoms worsen.

Atlantic sea nettles are found along the U.S. East Coast, from Cape Cod in Massachusetts to the Caribbean and Gulf of Mexico, according to the Aquarium of the Pacific in Long Beach, California. This sea creature has a saucer-shaped medusa (the "bell" part of the body); four thick, long, lacy arms; and between four and 40 long, thread-like tentacles, the aquarium reported.

These jellyfish vary in color, depending on their habitat. Atlantic sea nettles in the Chesapeake Bay and the open ocean tend to be pink to reddish-maroon, with red stripes that point toward their yellow tentacles, while jellies in the low-salt waters of estuaries have white bells and no stripes, according to the Aquarium of the Pacific.

The jellies' bells vary from 4 to 8 inches (10 to 25 centimeters) in diameter. They gobble up ctenophores (comb jellies), as well as young minnows and other small fish, mosquito larvae, bay anchovy eggs, and copepods and other zooplankton, according to the Aquarium of the Pacific.

Few predators, save for sea turtles, prey on Atlantic sea nettles, so their numbers are largely influenced by rain and heat, according to an article in Save the Bay magazine, which focuses on the Chesapeake Bay. These jellies prefer warm, salty water, so their populations tend to spike during dry and hot summers, the magazine reported.

Jellyfish blooms aren't a rare event, especially in summertime. Overfishing has led to fewer predators that compete with and prey on jellyfish, and nutrient-rich pollution, such as runoff water full of fertilizer, can lead to phytoplankton blooms, creating an all-you-can-eat buffet for jellies, Live Science previously reported.

However, the overarching reasons behind jellyfish blooms are likely more complex, a 2012 study published in the journal BioScience found, and a 2013 study published in the Proceedings of the National Academy of Sciences suggested that while human activity does appear to effect on jellyfish numbers, jellyfish populations might also naturally rise and fall in

decades-long oscillations, although more research is needed to say so for sure.

livescience.com, 9 July 2021

https://www.livescience.com

Why planting tons of trees isn't enough to solve climate change

2021-07-09

Trees are symbols of hope, life and transformation. They're also increasingly touted as a straightforward, relatively inexpensive, ready-for-prime-time solution to climate change.

When it comes to removing human-caused emissions of the greenhouse gas carbon dioxide from Earth's atmosphere, trees are a big help. Through photosynthesis, trees pull the gas out of the air to help grow their leaves, branches and roots. Forest soils can also sequester vast reservoirs of carbon.

Earth holds, by one estimate, as many as 3 trillion trees. Enthusiasm is growing among governments, businesses and individuals for ambitious projects to plant billions, even a trillion more. Such massive tree-planting projects, advocates say, could do two important things: help offset current emissions and also draw out CO2 emissions that have lingered in the atmosphere for decades or longer.

Can trees save the world?

Lately, society has been putting a lot of pressure on trees to get us out of the climate change emergency we're in. There's no doubt that trees make life better in many respects, but there are right ways and plenty of wrong ways to protect and grow the forests.

Even in the politically divided United States, large-scale tree-planting projects have broad bipartisan support, according to a spring 2020 poll by the Pew Research Center. And over the last decade, a diverse garden of tree-centric proposals — from planting new seedlings to promoting natural regrowth of degraded forests to blending trees with crops and pasturelands — has sprouted across the international political landscape.

Trees "are having a bit of a moment right now," says Joe Fargione, an ecologist with The Nature Conservancy who is based in Minneapolis. It helps that everybody likes trees. "There's no anti-tree lobby. [Trees]

Earth holds, by one estimate, as many as 3 trillion trees.

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have lots of benefits for people. Not only do they store carbon, they help provide clean air, prevent soil erosion, shade and shelter homes to reduce energy costs and give people a sense of well-being."

Conservationists are understandably eager to harness this enthusiasm to combat climate change. "We're tapping into the zeitgeist," says Justin Adams, executive director of the Tropical Forest Alliance at the World Economic Forum, an international nongovernmental organization based in Geneva. In January 2020, the World Economic Forum launched the One Trillion Trees Initiative, a global movement to grow, restore and conserve trees around the planet. One trillion is also the target for other organizations that coordinate global forestation projects, such as Plant-for-the-Planet's Trillion Tree Campaign and Trillion Trees, a partnership of the World Wildlife Fund, the Wildlife Conservation Society and other conservation groups.

Yet, as global eagerness for adding more trees grows, some scientists are urging caution. Before moving forward, they say, such massive tree projects must address a range of scientific, political, social and economic concerns. Poorly designed projects that don't address these issues could do more harm than good, the researchers say, wasting money as well as political and public goodwill. The concerns are myriad: There's too much focus on numbers of seedlings planted, and too little time spent on how to keep the trees alive in the long term, or in working with local communities. And there's not enough emphasis on how different types of forests sequester very different amounts of carbon. There's too much talk about trees, and not enough about other carbon-storing ecosystems.

"There's a real feeling that … forests and trees are just the idea we can use to get political support" for many, perhaps more complicated, types of landscape restoration initiatives, says Joseph Veldman, an ecologist at Texas A&M University in College Station. But that can lead to all kinds of problems, he adds. "For me, the devil is in the details."

The root of the problem

The pace of climate change is accelerating into the realm of emergency, scientists say. Over the last 200 years, human-caused emissions of greenhouse gases, including CO2 and methane, have raised the average temperature of the planet by about 1 degree Celsius (SN: 12/22/18 & 1/5/19, p. 18).

The litany of impacts of this heating is familiar by now. Earth's poles are rapidly shedding ice, which raises sea levels; the oceans are heating up,

threatening fish and food security. Tropical storms are becoming rainier and lingering longer, and out of control wildfires are blazing from the Arctic to Australia (SN: 12/19/20 & 1/2/21, p. 32).

The world's oceans and land-based ecosystems, such as forests, absorb about half of the carbon emissions from fossil fuel burning and other industrial activities. The rest goes into the atmosphere. So "the majority of the solution to climate change will need to come from reducing our emissions," Fargione says. To meet climate targets set by the 2015 Paris Agreement, much deeper and more painful cuts in emissions than nations have pledged so far will be needed in the next 10 years.

But increasingly, scientists warn that reducing emissions alone won't be enough to bring Earth's thermostat back down. "We really do need an all-hands-on-deck approach," Fargione says. Specifically, researchers are investigating ways to actively remove that carbon, known as negative emissions technologies. Many of these approaches, such as removing CO_2 directly from the air and converting it into fuel, are still being developed.

But trees are a ready kind of negative emissions "technology," and many researchers see them as the first line of defense. In its January 2020 report, "CarbonShot," the World Resources Institute, a global nonprofit research organization, suggested that large and immediate investments in reforestation within the United States will be key for the country to have any hope of reaching carbon neutrality — in which ongoing carbon emissions are balanced by carbon withdrawals — by 2050. The report called for the U.S. government to invest $4 billion a year through 2030 to support tree restoration projects across the United States. Those efforts would be a bridge to a future of, hopefully, more technologies that can pull large amounts of carbon out of the atmosphere.

The numbers game

Earth's forests absorb, on average, 16 billion metric tons of CO_2 annually, researchers reported in the March Nature Climate Change. But human activity can turn forests into sources of carbon: Thanks to land clearing, wildfires and the burning of wood products, forests also emit an estimated 8.1 billion tons of the gas back to the atmosphere.

That leaves a net amount of 7.6 billion tons of CO_2 absorbed by forests per year — roughly a fifth of the 36 billion tons of CO_2 emitted by humans in 2019. Deforestation and forest degradation are rapidly shifting the balance. Forests in Southeast Asia now emit more carbon than they absorb due to clearing for plantations and uncontrolled fires. The Amazon's forests

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may flip from carbon sponge to carbon source by 2050, researchers say (SN Online: 1/10/20). The priority for slowing climate change, many agree, should be saving the trees we have.

Forests in flux

While global forests were a net carbon sink of about 7.6 gigatons of carbon dioxide per year from 2001 to 2019, forests in areas such as Southeast Asia and parts of the Amazon began releasing more carbon than they store.

Just how many more trees might be mustered for the fight is unclear, however. In 2019, Thomas Crowther, an ecologist at ETH Zurich, and his team estimated in Science that around the globe, there are 900 million hectares of land — an area about the size of the United States — available for planting new forests and reviving old ones (SN: 8/17/19, p. 5). That land could hold over a trillion more trees, the team claimed, which could trap about 206 billion tons of carbon over a century.

That study, led by Jean-Francois Bastin, then a postdoc in Crowther's lab, was sweeping, ambitious and hopeful. Its findings spread like wildfire through media, conservationist and political circles. "We were in New York during Climate Week [2019], and everybody's talking about this paper," Adams recalls. "It had just popped into people's consciousness, this unbelievable technology solution called the tree."

To channel that enthusiasm, the One Trillion Trees Initiative incorporated the study's findings into its mission statement, and countless other tree-planting efforts have cited the report.

But critics say the study is deeply flawed, and that its accounting — of potential trees, of potential carbon uptake — is not only sloppy, but dangerous. In 2019, Science published five separate responses outlining numerous concerns. For example, the study's criteria for "available" land for tree planting were too broad, and the carbon accounting was inaccurate because it assumes that new tree canopy cover equals new carbon storage. Savannas and natural grasslands may have relatively few trees, critics noted, but these regions already hold plenty of carbon in their soils. When that carbon is accounted for, the carbon uptake benefit from planting trees drops to perhaps a fifth of the original estimate.

There's also the question of how forests themselves can affect the climate. Adding trees to snow-covered regions, for example, could increase the absorption of solar radiation, possibly leading to warming.

"Their numbers are just so far from anything reasonable," Veldman says. And focusing on the number of trees planted also sets up another problem, he adds — an incentive structure that is prone to corruption. "Once you set up the incentive system, behaviors change to basically play that game."

Adams acknowledges these concerns. But, the One Trillion Trees Initiative isn't really focused on "the specifics of the math," he says, whether it's the number of trees or the exact amount of carbon sequestered. The goal is to create a powerful climate movement to "motivate a community behind a big goal and a big vision," he says. "It could give us a fighting chance to get restoration right."

Other nonprofit conservation groups, like the World Resources Institute and The Nature Conservancy, are trying to walk a similar line in their advocacy. But some scientists are skeptical that governments and policy makers tasked with implementing massive forest restoration programs will take note of such nuances.

"I study how government bureaucracy works," says Forrest Fleischman, who researches forest and environmental policy at the University of Minnesota in St. Paul. Policy makers, he says, are "going to see 'forest restoration,' and that means planting rows of trees. That's what they know how to do."

Counting carbon

How much carbon a forest can draw from the atmosphere depends on how you define "forest." There's reforestation — restoring trees to regions where they used to be — and afforestation — planting new trees where they haven't historically been. Reforestation can mean new planting, including crop trees; allowing forests to regrow naturally on lands previously cleared for agriculture or other purposes; or blending tree cover with croplands or grazing areas.

In the past, the carbon uptake potential of letting forests regrow naturally was underestimated by 32 percent, on average — and by as much as 53 percent in tropical forests, according to a 2020 study in Nature. Now, scientists are calling for more attention to this forestation strategy.

If it's just a matter of what's best for the climate, natural forest regrowth offers the biggest bang for the buck, says Simon Lewis, a forest ecologist at University College London. Single-tree commercial crop plantations, on the other hand, may meet the technical definition of a "forest" — a certain

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concentration of trees in a given area — but factor in land clearing to plant the crop and frequent harvesting of the trees, and such plantations can actually release more carbon than they sequester.

Comparing the carbon accounting between different restoration projects becomes particularly important in the framework of international climate targets and challenges. For example, the 2011 Bonn Challenge is a global project aimed at restoring 350 million hectares by 2030. As of 2020, 61 nations had pledged to restore a total of 210 million hectares of their lands. The potential carbon impact of the stated pledges, however, varies widely depending on the specific restoration plans.

Levels of protection

The Bonn Challenge aims to globally reforest 350 million hectares of land. Allowing all to regrow naturally would sequester 42 gigatons of carbon by 2100. Pledges of 43 tropical and subtropical nations that joined by 2019 — a mix of plantations and natural regrowth — would sequester 16 gigatons of carbon. If some of the land is later converted to biofuel plantations, sequestration is 3 gigatons. With only plantations, carbon storage is 1 gigaton.

In a 2019 study in Nature, Lewis and his colleagues estimated that if all 350 million hectares were allowed to regrow natural forest, those lands would sequester about 42 billion metric tons (gigatons in chart above) of carbon by 2100. Conversely, if the land were to be filled with single-tree commercial crop plantations, carbon storage drops to about 1 billion metric tons. And right now, plantations make up a majority of the restoration plans submitted under the Bonn Challenge.

Striking the right balance between offering incentives to landowners to participate while also placing certain restrictions remains a tricky and long-standing challenge, not just for combating the climate emergency but also for trying to preserve biodiversity (SN: 8/1/20, p. 18). Since 1974, Chile, for example, has been encouraging private landowners to plant trees through subsidies. But landowners are allowed to use these subsidies to replace native forestlands with profitable plantations. As a result, Chile's new plantings not only didn't increase carbon storage, they also accelerated biodiversity losses, researchers reported in the September 2020 Nature Sustainability.

The reality is that plantations are a necessary part of initiatives like the Bonn Challenge, because they make landscape restoration economically viable for many nations, Lewis says. "Plantations can play a part, and so can

agroforestry as well as areas of more natural forest," he says. "It's important to remember that landscapes provide a whole host of services and products to people who live there."

But he and others advocate for increasing the proportion of forestation that is naturally regenerated. "I'd like to see more attention on that," says Robin Chazdon, a forest ecologist affiliated with the University of the Sunshine Coast in Australia as well as with the World Resources Institute. Naturally regenerated forests could be allowed to grow in buffer regions between farms, creating connecting green corridors that could also help preserve biodiversity, she says. And "it's certainly a lot less expensive to let nature do the work," Chazdon says.

Indeed, massive tree-planting projects may also be stymied by pipeline and workforce issues. Take seeds: In the United States, nurseries produce about 1.3 billion seedlings per year, Fargione and colleagues calculated in a study reported February 4 in Frontiers in Forests and Global Change. To support a massive tree-planting initiative, U.S. nurseries would need to at least double that number.

A tree-planting report card

From China to Turkey, countries around the world have launched enthusiastic national tree-planting efforts. And many of them have become cautionary tales.

China kicked off a campaign in 1978 to push back the encroaching Gobi Desert, which has become the fastest-growing desert on Earth due to a combination of mass deforestation and overgrazing, exacerbated by high winds that drive erosion. China's Three-North Shelter Forest Program, nicknamed the Great Green Wall, aims to plant a band of trees stretching 4,500 kilometers across the northern part of the country. The campaign has involved millions of seeds dropped from airplanes and millions more seedlings planted by hand. But a 2011 analysis suggested that up to 85 percent of the plantings had failed because the nonnative species chosen couldn't survive in the arid environments they were plopped into.

More recently, Turkey launched its own reforestation effort. On November 11, 2019, National Forestation Day, volunteers across the country planted 11 million trees at more than 2,000 sites. In Turkey's Çorum province, 303,150 saplings were planted in a single hour, setting a new world record.

Within three months, however, up to 90 percent of the new saplings inspected by Turkey's agriculture and forestry trade union were dead,

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according to the union's president, Şükrü Durmuş, speaking to the Guardian (Turkey's minister of agriculture and forestry denied that this was true). The saplings, Durmuş said, died due to a combination of insufficient water and because they were planted at the wrong time of year, and not by experts.

Some smaller-scale efforts also appear to be failing, though less spectacularly. Tree planting has been ongoing for decades in the Kangra district of Himachal Pradesh in northern India, says Eric Coleman, a political scientist at Florida State University in Tallahassee, who's been studying the outcomes. The aim is to increase the density of the local forests and provide additional forest benefits for communities nearby, such as wood for fuel and fodder for grazing animals. How much money was spent isn't known, Coleman says, because there aren't records of how much was paid for seeds. "But I imagine it was in the millions and millions of dollars."

Coleman and his colleagues analyzed satellite images and interviewed members of the local communities. They found that the tree planting had very little impact one way or the other. Forest density didn't change much, and the surveys suggested that few households were gaining benefits from the planted forests, such as gathering wood for fuel, grazing animals or collecting fodder.

But massive tree-planting efforts don't have to fail. "It's easy to point to examples of large-scale reforestation efforts that weren't using the right tree stock, or adequately trained workforces, or didn't have enough investment in … postplanting treatments and care," Fargione says. "We … need to learn from those efforts."

Speak for the trees

Forester Lalisa Duguma of World Agroforestry in Nairobi, Kenya, and colleagues explored some of the reasons for the very high failure rates of these projects in a working paper in 2020. "Every year there are billions of dollars invested [in tree planting], but forest cover is not increasing," Duguma says. "Where are those resources going?"

In 2019, Duguma raised this question at the World Congress on Agroforestry in Montpellier, France. He asked the audience of scientists and conservationists: "How many of you have ever planted a tree seedling?" To those who raised their hands, he asked, "Have they grown?"

Some respondents acknowledged that they weren't sure. "Very good! That's what I wanted," he told them. "We invest a lot in tree plantings, but we are not sure what happens after that."

It comes down to a deceptively simple but "really fundamental" point, Duguma says. "The narrative has to change — from tree planting to tree growing."

The good news is that this point has begun to percolate through the conservationist world, he says. To have any hope of success, restoration projects need to consider the best times of year to plant seeds, which seeds to plant and where, who will care for the seedlings as they grow into trees, how that growth will be monitored, and how to balance the economic and environmental needs of people in developing countries where the trees might be planted.

"That is where we need to capture the voice of the people," Duguma says. "From the beginning."

Even as the enthusiasm for tree planting takes root in the policy world, there's a growing awareness among researchers and conservationists that local community engagement must be built into these plans; it's indispensable to their success.

"It will be almost impossible to meet these targets we all care so much about unless small farmers and communities benefit more from trees," as David Kaimowitz of the United Nations' Food and Agriculture Organization wrote March 19 in a blog post for the London-based nonprofit International Institute for Environment and Development.

For one thing, farmers and villagers managing the land need incentives to care for the plantings and that includes having clear rights to the trees' benefits, such as food or thatching or grazing. "People who have insecure land tenure don't plant trees," Fleischman says.

Fleischman and others outlined many of the potential social and economic pitfalls of large-scale tree-planting projects last November in BioScience. Those lessons boil down to this, Fleischman says: "You need to know something about the place … the political dynamics, the social dynamics.… It's going to be very different in different parts of the world."

The old cliché — think globally, act locally — may offer the best path forward for conservationists and researchers trying to balance so many different needs and still address climate change.

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"There are a host of sociologically and biologically informed approaches to conservation and restoration that … have virtually nothing to do with tree planting," Veldman says. "An effective global restoration agenda needs to encompass the diversity of Earth's ecosystems and the people who use them."

sciencenews.org, 9 July 2021

https://www.sciencenews.org

Why health officials are watching new 'lambda' coronavirus variant

2021-07-07

A coronavirus variant known as "lambda" is gaining the attention of health officials as it spreads around the world.

The variant, also known as C.37, was first detected in Peru in August 2020, according to the World Health Organization (WHO). On June 14, the agency designated C.37 a global "variant of interest," or VOI, and named it lambda.

VOI means the variant is increasingly showing up in communities and has mutations that are predicted to have some effect on viral characteristics, such as increased transmissibility. In contrast, officials use the term "variant of concern," or VOC, once reliable data shows that the variant has increased transmissibility — such as what's been seen with the delta variant — or other worrying features.

So far, lambda has been detected in 29 countries, with high levels of spread in South American countries. In recent months, the lambda variant was detected in 81% of COVID-19 cases in Peru that underwent genetic sequencing, according to the WHO. And in Chile, the variant was detected in about one-third of cases, the WHO said.

Most recently, the variant popped up in the United Kingdom. On June 25, Public Health England reported six cases of the lambda variant, all of which were tied to overseas travel.

Officials are monitoring the lambda variant because it carries a number of mutations that could potentially aid its spread. The variant has seven mutations in the virus's "spike protein" compared with the original strain of SARS-CoV-2 detected in Wuhan, China.

So far, lambda has been detected in 29 countries, with high levels of spread in South American countries.

Some of these mutations have the potential to increase transmissibility of the virus or to reduce the ability of certain antibodies to neutralize, or inactivate, the virus, according to the WHO. For example, lambda has a mutation known as F490S located in the spike protein's receptor-binding domain (RBD), where the virus first docks onto human cells. A paper published in the July issue of the journal Genomics identified F490S as a likely "vaccine escape mutation" that could both make the virus more infectious and disrupt the ability of vaccine-generated antibodies to recognize the variant.

Still, these effects are theoretical at this point. "There is currently no evidence that this variant causes more severe disease or renders the vaccines currently deployed any less effective," according to Public Health England. More studies are needed to see if these mutations really do affect how the virus behaves.PLAY SOUND

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https://www.livescience.com

Australia's top supplier of lab mice and rats to shut down operations

2021-07-07

Australia's leading breeder and supplier of lab mice and rats is preparing to close its doors, leaving researchers scrambling for alternatives.

"I wish to inform you that the Animal Resources Center (ARC) will be winding up its operations over the next 12-18 months," acting CEO Kirsty Moynihan wrote in an email to customers on 2 July. She explained that ARC, located near Perth in the state of Western Australia, "is not able to operate in a financially self-sustaining manner," which is required by the state legislation that created the center.

The closure "would have major implications for Australia's medical research effort," says Malcolm France, a Sydney-based veterinarian who advises institutions on the care and management of animals used in research. He says ARC has been Australia's leading breeder and supplier of specialized strains of lab mice and rats for more than 30 years, supplying universities and medical research institutes in Australia, Indonesia, Malaysia, New Zealand, and Singapore.

She explained that ARC, located near Perth in the state of Western Australia, "is not able to operate in a financially self-sustaining manner," which is required by the state legislation that created the center.

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Under its authorizing law, ARC is supposed to be financially self-supporting. But the Western Australia government has been providing annual subsidies of about AU$1.3 million ($975,000), France says. A further complication is that Murdoch University wants to reclaim land it currently leases to ARC, according to Moynihan's letter.

In an email, a spokesperson for the Western Australia government explained that ARC was originally intended to supply animals to Western Australia research institutions, yet in recent years more than 80% of the center's rats and mice have gone to laboratories in other Australian states and overseas. With ARC losing money, those out-of-state sales are "effectively being subsidized by [Western Australia] taxpayers."

The spokesperson added that a 2019 external review concluded that ARC "was not financially viable." That finding led to the decision to close the center.

Alternative breeders could replace ARC's current offerings only "to a very limited extent," France says. The country's other major supplier of lab animals concentrates on breeding specific lines for particular research projects; ARC handles well-established strains that are used worldwide. France worries that ARC's closure could result in the loss of rodent breeding infrastructure, as well as the technical expertise in quality and infection control accumulated by ARC's 60 or so staff members.

"It's a shame to be losing [ARC], but it looks like the research community will have no choice but to come up with another solution," France says. It could be an opportunity to create a new, more efficient facility located in eastern Australia, where most medical research is concentrated, he says.

sciencemag.org, 7 July 2021

https://www.sciencemag.org

Sea otters stay warm thanks to leaky mitochondria in their muscles

2021-07-08

Sea otters' secret to staying warm isn't in thick stores of blubber. It's in their muscles.

Leaks in the energy-generating parts of muscle cells help otters maintain a resting metabolism three times as fast as predicted for a creature their size, researchers report in the July 9 Science. The find shows how otters meet

"To me, this is probably one of the clearest pieces of evidence saying, 'Here's how they did it,'" Williams says.

the challenge of staying warm at sea — and could apply to other marine mammals, too.

"This could be a game changer in terms of how we think about the evolution of all marine mammals, not just sea otters," says Terrie Williams, an ecophysiologist at the University of California, Santa Cruz, who was not involved in the study. To dwell in cold oceans, mammals must have developed ways to regulate their body temperature amid the chill. "To me, this is probably one of the clearest pieces of evidence saying, 'Here's how they did it,'" Williams says.

Other marine mammals have high metabolisms to cope with cold water, too, but they also often rely on large bodies and blubber to stay toasty (SN: 12/14/18). Sea otters are lean and compact, the smallest mammals in the ocean, bobbing like furry barrels on waves. And the insulating properties of sea otters' fur — the densest on the planet — can't fully protect them from losing too much heat. Water transfers heat 23 times as efficiently as air, and small bodies with less surface area lose heat faster, even when covered in fluff.

"Being a small-bodied marine mammal in cold waters presents a real thermal challenge," says Traver Wright, a comparative physiologist at Texas A&M University in College Station. Scientists already knew sea otters rely on an extreme metabolism to maintain, on average, a 37° Celsius body temperature, eating 25 percent of their body mass in food every day (SN: 6/13/14). But researchers didn't understand the cellular origins of "that revved-up metabolism for heat generation," Wright says.

Wright and colleagues searched for the heat source in otters' muscles. Skeletal muscle makes up 40 to 50 percent of most mammals' body mass, so it affects the whole body's metabolism. The team collected tissue from 21 captive and wild sea otters, ranging from babies to adults. Then, using a device called a respirometer, researchers measured otter muscle cells' respiratory capacity in different states of oxygen flow compared with other animals — including humans, Iditarod sled dogs and elephant seals. The rate of oxygen flow offers an indirect measurement of cells' heat production.

Leaks in mitochondria — the energy-generating part of cells — generate extra heat and cause sea otters' extreme metabolism, the researchers found. Metabolism describes how food gets converted into energy in cells. Mitochondria pump protons across their inner membrane to store energy that can be used to power the cell. But if those protons leak back over the membrane before being used for work, that energy is lost as heat. Because

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these proton leaks increase the amount of energy lost as heat, otters need to eat more food to make up for that lost energy, revving up their metabolism.

Other mammals — including extremely small mice with high metabolisms — can also generate heat this way. But sea otters are much better at it: These proton leaks account for about 40 percent of otters' muscle cells' total respiratory capacity, higher than any known mammal. Producing heat this way helps the animals stay comfortable in 0° C Pacific waters. "That message is loud and clear, and just brilliant," Williams says.

Sea otters' high leak capacity "is not necessarily what they're running all the time," Wright says, but probably can be activated when otters need to generate more warmth. Scientists don't yet know how otters' cells turn this process on and off.

Baby otters don't yet have the muscle mass to stay warm through these leaks, but their muscle cells generate heat at adult rates, the researchers found, showing that proton leak begins early. Finding similar leak capacities in wild and captive otters of different ages suggests that these leaks are the "driving force" behind otters' metabolism, Wright says.

It's not yet clear if otters inherit this trait or develop it with exposure to cold water. "We don't know if this is inherent," Wright says, "or if this is something that quickly comes on after birth as a means of generating heat on demand."

Finding the cellular source of sea otters' souped-up metabolism could help scientists better understand how other marine mammals cope with frigid water. And it could lead to new insights into how the ancestors of these creatures first evolved to live and thrive in the seas.

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His experiment cemented a commonly held idea.

Textbooks say most birds can't smell. Scientists are proving them wrong

2021-07-07

Almost 200 years ago, the renowned U.S. naturalist John James Audubon hid a decaying pig carcass under a pile of brush to test vultures' sense of smell. When the birds overlooked the pig—while one flocked to a nearly odorless stuffed deer skin—he took it as proof that they rely on vision, not smell, to find their food. His experiment cemented a commonly held idea.

Despite later evidence that vultures and a few specialized avian hunters use odors after all, the dogma that most birds aren't attuned to smell endured.

Now, that dogma is being eroded by findings on birds' behavior and molecular hardware, two of which were published just last month. One showed storks home in on the smell of freshly mowed grass; another documented scores of functional olfactory receptors in multiple bird species. Researchers are realizing, says evolutionary biologist Scott Edwards of Harvard University, that "olfaction has a lot of impact on different aspects of bird biology."

Forty years ago, when ethologist Floriano Papi proposed that homing pigeons find their way back to a roost by sniffing out its chemical signature, his colleagues scoffed at the idea. They pointed out that birds have several other keen senses to guide them, including sight and, in the case of pigeons and some other species, a magnetic sense. "By then, biological textbooks already stated unequivocally that birds have little to no sense of smell, and many people still believe it—even scientists," says Danielle Whittaker, a chemical ecologist at Michigan State University.

Still, contrary evidence was already accumulating. In the 1960s, ornithologist Kenneth Stager found vultures were attracted to boxes with a carcass hidden inside and fans that vented the odors—as long as this bait wasn't too decomposed, as was likely the case in Audubon's experiment. Researchers also found that albatrosses, shearwaters, and some other seabirds find their fish prey by detecting a chemical released by the plankton the fish eat. But these birds, forced to navigate many kilometers across a featureless sea, seemed exceptional. In 2008, "You were part of the dark side if you talked about birds using olfaction," recalls Martin Wikelski, an ecologist at the Max Planck Institute for Ornithology.

That year, though, a graduate student at his institute, molecular ecologist Silke Steiger, analyzed nine bird genomes from across the avian family tree and uncovered many genes for olfactory receptors—proteins in the nasal passages that bind to odors and relay a signal to the brain. In species that don't rely much on smell (humans are an example), these genes often mutate and become nonfunctional. But the researchers confirmed that many of the birds' olfactory genes were intact. What's more, they found that the number of these genes correlated with the size of a bird species' olfactory bulb, the brain's smell center—further evidence that the receptors were functional.

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The genomes in that study were incomplete, however. Last month, Christopher Balakrishnan, an evolutionary biologist at East Carolina University, and graduate student Robert Driver examined some of the best available bird genomes and for some species found many more olfactory genes. Their analysis of genomes from a hummingbird, emu, chicken, zebra finch, and a tropical fruit eater called a manakin revealed scores of new olfactory receptors, they reported on 28 June in the journal Integrative and Comparative Biology.

That the emu has so many of these genes excites Whittaker, because this bird sits near the base of the bird family tree. "This result suggests that the ancestor to all birds must have had a very diverse set of olfactory receptor genes as well," she says. Smell must have been important to birds from the beginning, and comparisons of their olfactory receptor genes today confirm it remains so. Balakrishnan and Driver found that one diverse set of receptors unique to birds has split into multiple types specific to different bird lineages. That suggests these genes evolved rapidly as the birds diversified. Natural selection may have honed the genes to perform crucial tasks.

Wikelski and colleagues saw bird smell in action after they were inspired by a question from a curious primary school student. During an outreach program at a school in Radolfzell, Germany, the student asked the scientists how the local population of European white storks found their way to freshly cut meadows, where their insect and rodent prey were most exposed.

To find out, Wikelski piloted his plane in circles to observe a flock of 70 storks on sunny spring and summer days. Even when the storks couldn't see or hear the mowing, he and his colleagues noted, they homed in on mowed fields upwind of them, as if drawn to the smell of the cut grass. To confirm the suspicion, the team sprayed cut-grass smell—a mix of three volatile chemicals—onto fields that hadn't been mowed recently. The storks came flocking, the team reported on 18 June in Scientific Reports. The work "shows very clearly that these birds rely exclusively on their sense of smell to make foraging decisions," Whittaker says.

Other bird species may also respond to "calls" from injured plants, recent evidence shows. Two European birds, the great tit and the blue tit, locate insects that are attacking pine trees by detecting the volatile chemicals the stressed trees release, ecologist Elina Mäntylä of the Biology Centre of the Czech Academy of Sciences and colleagues reported in the September 2020 issue of Ecology and Evolution.

All these results show bird olfaction "should not be ignored," Mäntylä says. Driver adds that they might also point to a new form of natural pest control, in which farmers or foresters could treat threatened flora with chemicals that entice birds to come and gobble up invasive insects.

Other studies suggest olfaction might guide social interactions between birds. Whittaker's team has focused on preen oil, which birds secrete from a gland at the base of the tail and rub onto their feathers. The oil's chemical composition reveals the bird's species, sex, aggressiveness, and reproductive state. Females produce much more of these odorous chemicals, Whittaker and her colleagues reported in January in the Journal of Chemical Ecology, suggesting they depend more on odors to communicate, lacking the flashy feathers and songs that males rely on. Use of these cues is "likely widespread," says Steiger, now at the German chemical company BASF SE, "but simply not yet investigated well enough."

That's changing fast, as studies of bird olfaction expand into new species. Published papers on the topic have doubled every decade since 1992, reaching 80 this past year. The field is, belatedly, putting Audubon's misconception to rest and acknowledging that birds—champions of flight, vision, and song—have another power as well.

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What are invasive species?

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An invasive species is a type of animal, plant, fungus or any other living thing that has arrived in a new environment and can harm other species there.

You might hear the term "invasive species" used interchangeably with "naturalized species," "exotic species," "noxious species" and "non-native species." Although each of these terms has a slightly different meaning, they all refer to members of a species living in an area they aren't originally from. "An invasive species is almost always from somewhere else and there's concern that it could be harming the system," said Katharine Suding, an ecologist at the University of Colorado Boulder.

Species invasions are on the rise: Of all invasive species discovered during the past 200 years, about 40% were discovered after 1970, according to a study published in 2017 in the journal Nature Communications. Often,

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invasive species arrive in the new environment as people's pets, additions to someone's garden or stowaways on a boat.

Global trade regularly carries species to new places around the world, inadvertently or deliberately. A 2009 review in the Journal of Applied Ecology suggests that the recent upswing in invasions has been propelled by globalization, economic growth and more efficient international transportation. The countries with the highest number of invasive species include the United States, France, Australia and China, a 2016 study in the journal Global Ecology and Biogeography found.PLAY SOUND

WHY ARE INVASIVE SPECIES A PROBLEM?

In 2010, scientists discovered Austropuccinia psidii, an invasive fungus from South America, in Australia. When the fungus spreads on Australia's eucalyptus trees, it takes over, stripping their branches of leaves, stunting their growth and sometimes killing them.

This fungus is an example of how invasive species can directly harm native species — in this case, by killing them. But other invasive species harm native species indirectly. For example, fish called bighead carp (Hypophthalmichthys nobilis) were brought to the United States from China in 1973 and now swim around the Mississippi River watershed, gorging on plankton. Plankton form the base of the watershed's food web, so when the carp eat the plankton, it results in a food shortage for small, native filter-feeding fish. When these small fish starve and subsequently disappear, so do the bigger fish that eat them. In this way, the carp create a nutrient shortage that ripples through the ecosystem, according to researchers at the University of Michigan.

Other invasive species prey on native species or compete with them for water and habitat and, in doing so, threaten biodiversity (the variety of life in an ecosystem).

Invasive species can also cost people a lot of money. For example, new pests or pathogens can threaten crops and aquaculture. Invasive species management and damages have cost an average of $26.8 billion USD globally since 1970, according to a 2021 analysis published in the journal Nature. In response, conservationists, governments and land managers often attempt to mitigate damage caused by invasive species by eradicating them or keeping their populations low.

ARE INVASIVE SPECIES ALWAYS BAD?

By definition, invasive species can harm other species in their new environment, but that doesn't necessarily mean they will.

"Many invasions occur where the [invasive] species can't survive or do well in the new environment," Suding told Live Science. Of those that establish themselves in the new environment, some invasive populations will grow abundant, while others will remain small and innocuous, she added. In rare cases, invasive species may even benefit some members of their new environment.

Take the tamarisk, for example. This genus of Eurasian shrubs was introduced to the United States as an ornamental plant in the 19th century and has since spread throughout the western U.S. The tamarisk causes problems: It sucks up a lot of water and secretes salt into the ground, thereby preventing native trees from growing around it. However, an endangered bird called the southwestern willow flycatcher (Empidonax traillii extimus) has begun breeding and feeding on the tamarisk, at least since the 1990s, according to a 2008 report in the journal Restoration Ecology. In this case, the invasive shrub is hurting some native species while helping another, by providing habitat to a bird in need.

Climate change is altering the way ecologists think about invasive species because of the shifting habitat borders for many species, creating habitat in parts of the globe where some species might have previously been considered invasive. Species around the globe are moving uphill and toward the poles as average temperatures rise, a 2017 review published in the journal Science found. And mosquitoes' habitat is expanding latitudinally and into higher elevations, putting more people at risk of diseases these insects carry, such as dengue and yellow fever, according to a 2019 study in the journal Nature Microbiology. Even though species pushed into a new environment by climate change fit the traditional criteria for invasive species, some ecologists give them their own designation: range-shifters.

Some ecologists have pushed back on the notion that invasive species always threaten ecosystems. A 2011 commentary by 19 ecologists, published in the journal Nature, argued that natural landscapes are changing permanently due to factors such as climate change, deforestation, land use practices and urbanization and, therefore, that conservationists should change the way they manage species. Rather than judging a species based on where it originated, the authors wrote, conservationists should focus on how species function in an environment, taking into account both the good and the bad.

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In some ways, this new mindset is already taking hold. As native ranges shift and expand, conservationists have begun facilitating some species' transitions to new environments, rather than trying to eradicate them in the new areas, Suding said. Some conservationists have even moved species to new habitats on purpose, in a bid to help them survive in an altered global climate — a process called assisted migration.

WAYS TO MANAGE AND EXTERMINATE INVASIVE SPECIES

When conservationists decide what to do about an invasive species, they perform a sort of triage, prioritizing species based on the threat they pose and how hard it will be to eradicate or manage them. In some cases, that leads to an all-out eradication effort; in others, conservationists try to keep the population of the invasive species low enough that it poses minimal danger.

In 2005, conservationists completed a four-year mission to eradicate 80,000 feral goats that roamed the Galápagos Islands. The goats had been brought to the archipelago about a century earlier and had spent decades grazing the vegetation, causing erosion and competing with tortoises for food and habitat. Goat cullers tracked them down with helicopters, corralled them and killed them — an operation that cost more than $6 million, according to a 2009 article published in The Journal of Wildlife Management. This large-scale eradication effort was considered a success, with vegetation rebounding after a couple of years, the researchers said in a 2011 study published in the journal PLOS One.

In 2009, researchers attempted to use crab traps to eradicate European green crabs (Carcinus maenas) from a lagoon in California. But the effort proved futile; after the team removed 90% of the crabs, the population more than doubled by the following year. Adult crabs eat their young, and the researchers had removed most of the adults, leaving the juvenile population unchecked, the researchers wrote in a 2021 study published in the journal Proceedings of the National Academy of Sciences. Now, conservationists use a less aggressive strategy, keeping the crab population low enough to protect native species without attempting to eradicate them.

Recently, conservationists tested some creative strategies for managing invasive species. The U.S. Department of Agriculture tried to control the invasive tamarisk by releasing another non-native genus: leaf-eating beetles (Diorhabda spp.). In Florida, where invasive lionfish harm coral reefs, chefs have added the fish to their menus and fishers compete for prizes in lionfish derbies. These strategies have yielded mixed results. In

the case of lionfish, studies have found that fishing can temporarily shrink their populations, but some ecologists warn that creating a market for lionfish might discourage conservation in the long run.

The best time to eradicate a dangerous invasive species is shortly after it has arrived, when it has been spotted once or twice, Suding said. "Once a species gets really abundant," she said, "you can imagine it's super hard to eradicate it."

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